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A COMPARISON OF AMERICAN AND EUROPEAN COMMERCIAL CONDITIONS.

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Mr. Clark is the manager of foreign trade of one of the very largest American electric companies. He therefore expresses conclusions based upon an unrivalled fund of observation and experience.—THE EDITORS.

THE question is frequently asked "what are the most effective methods for increasing America's foreign trade?" A proper reply would be: "Take advantage of existing conditions and the natural laws of trade will accomplish the rest."

The object of this article is to give a true appreciation of some of these existing conditions in various countries, and as it is desired to state them as briefly as possible, there is necessity for using a number of statistical tables.

The balance of trade on exports and imports is an excellent standard by which to gauge the prosperity of nations, their commercial progress, and their position. It is by no means the only one, as subsequently shown; yet as it is the most frequently used, the tables on the following three pages are here inserted, that at the outset the conditions of the more important countries in this respect may be noted.

Balance of trade on exports and imports, important as it is, does not determine the net results to any nation from its financial and commercial relations abroad. The old and rich countries of Europe doubtless receive returns from their enormous foreign investments that more than offset the balances of trade which are against them; but it is, naturally, impossible to secure, or even to approximate, figures thereon.

IMPORTS AND EXPORTS OF MERCHANDISE OF THE PRINCIPAL COUNTRIES, 1892.

COMPILED FROM STATISTICS OF U. S. DEPARTMENT OF COMMERCE AND LABOR.

COUNTRIES.	IMPORTS.	EXPORTS.	TOTAL FOREIGN TRADE.	EXCESS OF IMPORTS OVER EXPORTS, i. e. Balance of Trade against Nation, with per cent. on total Foreign Trade.		EXCESS OF EXPORTS OVER IMPORTS, i. e. Balance of Trade in favor of Nation, with per cent. on total Foreign Trade.	
Argentina	$88.279,322	$109,402,375	$197,681,697			$21,123,053	10.7 %
Australia (Commonwealth of)	146,517,370	162,396,487	308,913,857			15,879,117	5.14
Austria-Hungary	252,763,703	293,424,916	546,188,619			40,661,213	7.45
Belgium	296,536,000	264,302,000	560,838,000	$32,234,000	5.74%		
Bulgaria	14,919,000	14,406,000	29,325,000	513,000	1.75		
Canada	115,170,830	105,488,798	220,659,628	9,682,032	4.		
Cape of Good Hope	58,290,840	46,170,126	104,460,966	12,120,174	11.62		
Chile	60,074,090	49,447,550	109,521,600	10,626,580	9.7		
China	141,315,853	107,302,367	248,618,220	34,013,486	13.64		
Denmark	86,976,000	67,621,000	154,597,000	19,355,000	12.52		
Egypt	44,939,191	65,946,135	110,885,326	21,006,944	18.92		
France	808,295,000	667,922,000	1,476,217,000	140,373,000	9.51		
Germany	956,415,000	703,078,000	1,659,493,000	253,337,000	25.26		
Greece	23,026,000	15,876,000	38,902,000	7,150,000	18.38		
India (British)	190,417,113	310,074,240	500,491,353			119,657,127	23.91
Italy	226,464,653	184,930,133	411,394,786	41,534,520	10.39		
Japan	50,321,521	63,825,743	114,147,264			13,504,222	11.85
Mexico	42,714,180	58,018,597	100,737,677			15,304,417	15.19
Netherlands	510,138,402	454,141,193	964,279,595	55,997,209	5.81		
Norway	53,596,500	31,847,200	85,443,700	21,749,300	25.47		
Portugal	33,295,000	26,601,000	59,896,000	6,694,000	11.18		
Russia	202,947,970	378,452,580	581,400,550			175,504,610	30.21
Spain	143,511,874	128,450,186	271,962,060	15,061,688	5.54		
Sweden	96,220,000	87,998,000	184,218,000	8,222,000	4.47		
Switzerland	167,796,208	126,926,299	294,722,557	40,869,909	13.83		
United Kingdom	1,969,415,018	1,062,160,918	3,031,575,936	907,254,100	29.94		
United States	776,248,924	854,729,454	1,630,978,378			78,480,530	4.81
Uruguay	19,030,000	26,834,000	26,834,000	45,864,000		7,804,000	17.

YEAR 1902.

Countries.	Imports.	Exports.	Total Foreign Trade.	Excess of Imports Over Exports, i. e. Balance of Trade against Nation, with per cent. on total Foreign Trade.		Excess of Exports Over Imports, i. e. Balance of Trade in favor of Nation, with per cent. on total Foreign Trade.	
Argentina	$99,432,882	$173,204,692	$272,637,574			$73,771,810	26.7 %
Australia (Commonwealth of)	197,960,650	213,713,452	411,674,102			15,752,802	3.85
Austria-Hungary	349,283,319	387,525,845	736,809,164			38,242,526	5.19
Belgium	459,472,000	371,620,000	831,092,000	$87,852,000	10.57%		
Bulgaria	13,751,000	20,011,000	33,762,000			6,260,000	18.54
Canada	224,810,528	214,401,674	439,212,202	10,408,854	2.37		
Cape of Good Hope	156,261,393	77,051,256	233,312,649	79,210,137	33.95		
Chile	48,336,294	67,846,187	116,182,481			19,509,893	16.79
China	198,363,896	134,720,216	333,084,112	63,643,680	19.11		
Denmark	151,349,000	85,730,000	237,079,000	65,619,000	23.		
Egypt	73,229,003	87,080,846	160,309,849			13,851,843	8.66
France	848,045,700	820,671,000	1,668,716,700	27,374,700	1.62		
Germany	1,340,178,000	1,113,313,000	2,453,491,000	226,865,000	9.24		
Greece	26,034,000	15,466,000	41,500,000	10,568,000	25.47		
India (British)	255,614,237	408,295,874	664,010,111			152,781,637	23.
Italy	342,718,351	284,174,782	626,893,133	58,543,569	9.32		
Japan	135,117,083	127,326,158	262,443,241	7,790,925	2.97		
Mexico	74,690,331	88,190,632	162,880,963			13,509,301	8.28
Netherlands	867,307,701	732,975,255	1,600,282,956	134,332,446	8.4		
Norway	78,869,000	45,146,500	124,015,500	33,722,500	27.19		
Portugal	60,459,000	31,868,000	92,327,000			28,591,000	30.97
Russia	305,614,110	392,214,988	697,829,098	28,591,000	30.97	86,600,878	12.4
Spain	175,499,321	154,164,194	329,663,515	21,235,127	6.19		
Sweden	134,603,000	105,154,000	239,757,000	29,449,000	12.25		
Switzerland	217,802,568	168,740,886	386,343,454	49,061,682	12.69		
United Kingdom	2,642,053,631	1,415,617,552	4,057,671,183	1,226,436,079	30.25		
United States	995,447,175	1,457,575,865	2,453,023,040			62,128,690	18.84
Uruguay	24,565,000	33,656,000	58,221,000			9,091,000	17.34

COMPARISONS OF YEARS 1892 AND 1902.

COUNTRIES.	INCREASE OF IMPORTS, WITH PER CENT. 1902 OVER 1892.		INCREASE OF EXPORTS, WITH PER CENT. 1902 OVER 1892.		INCREASE OF TOTAL FOREIGN TRADE, WITH PER CENT. 1902 OVER 1892.		PERCENTAGE OF BALANCE OF TRADE AGAINST NATION.		PERCENTAGE OF BALANCE OF TRADE IN FAVOR OF NATION.	
							1892.	1902.	1892.	1902.
Argentina	$11,153,560	12.63	$63,802,317	58.32	$74,955,877	37.91			10.7	26.7
Australia (Commonwealth of)	51,443,280	35.11	51,316,965	31.60	102,760,245	33.25			5.14	3.85
Austria-Hungary	96,519,616	38.18	94,100,929	32.07	190,620,545	36.72			7.45	5.19
Belgium	162,936,000	54.94	107,318,000	40.60	270,254,000	42.83	5.74	10.57		
Bulgaria (Decrease)	1,168,000	7.83	5,605,000	38.91	4,437,000	15.20	1.75			18.54
Canada	109,639,698	95.20	108,912,876	103.25	218,552,574		4.00	2.37		
Cape of Good Hope	97,970,553	168.08	30,881,126	66.89	128,851,679	123.42	11.62	33.95		
Chile (Decrease)	11,737,796	19.54	18,398,677	37.21	6,660,881		9.7			16.79
China	57,048,043	40.37	27,417,849	25.55	84,465,892	34.06	13.64	19.11		
Denmark	64,373,000	74.01	18,109,000	26.78	82,482,000	53.35	12.52	23.84		
Egypt	28,289,812	62.95	21,134,711	32.05	49,424,523	44.93	18.92			8.66
France	39,750,700	4.92	152,749,000	22.87	192,499,700	13.	9.51	1.62		
Germany	383,763,000	40.13	410,235,000	58.35	793,998,000	47.86	25.26	9.21		
Greece	3,008,000	13.06	(Dec) 410,000	2.58	2,598,000	6.68	18.38	25.47		
India (British)	65,197,124	34.24	98,321,634	31.71	163,518,758	32.7			23.91	23.06
Italy	116,253,698	51.34	99,244,649	53.67	215,498,347	52.43	10.39	9.32		
Japan	84,795,562	168.51	64,500,415	99.49	149,295,977	130.		2.97	11.85	
Mexico	31,976,251	74.86	30,181,035	52.02	62,157,286	52.15			15.19	8.28
Netherlands	357,169,299	70.01	278,834,062	61.40	636,003,361	65.98	5.81	8.4		
Norway	25,272,500	47.15	13,299,300	41.76	38,571,800	45.15	25.47	27.19		
Portugal	27,164,000	81.59	5,267,000	19.80	32,431,000	54.15	11.18	30.97		
Russia	102,666,140	50.59	13,762,408	3.63	116,428,548	50.			30.21	12.4
Spain	31,987,447	8.17	25,714,008	8.33	57,701,455	21.21	5.54	6.19		
Sweden	38,383,000	7.12	17,156,000	8.37	55,539,000	30.18	4.47	12.25		
Switzerland	50,006,360	29.80	41,814,587	32.94	91,820,947	31.16	13.83	12.69		
United Kingdom	672,638,613	34.15	353,456,634	33.28	1,026,095,247	33.86	29.94	30.25		
United States	219,198,251	22.24	602,846,411	70.73	822,044,662	50.31			4.81	18.84
Uruguay	5,535,000	29.09	7,822,000	25.42	13,357,000	26.95			17.00	17.34

An important feature, however, in determining the net positions of nations in their international trade, and one which can be closely approximated, is the earnings of their ocean carriers, viewed in connection with their balance of trade. Not all of these earnings are clear gain to a country's wealth, as is the balance of trade in its favor on exports and imports; for naturally, a nation pays to itself or to someone else, either directly or indirectly, the expense of transporting its imports, and available statistics do not separate coastwise from foreign commerce of all countries; yet from the following table important conclusions can be drawn as to the earnings of various countries from their vessels engaged in ocean traffic, most of these being employed in foreign trade.

The tonnage of vessels given is from Lloyd's Register; the earnings are estimated at the rate of $10 per rated ton on sailing vessels, and $40 per ton on steamers, which sums various authorities agree are a close approximation to actual results.

TOTAL TONNAGE AND APPROXIMATE EARNINGS OF MERCHANT SHIPPING OF THE WORLD.

EXCLUDING LAKE TRAFFIC OF THE UNITED STATES.

1900—1904.

COUNTRIES.	TONNAGE.		EARNINGS.
	Gross. Steam.	Sailing. Net.	Approximate Annual.
Argentina	70,862	24,918	$3,083,660
Austria-Hungary	557,745	20,952	22,519,320
Belgium	156,559	488	6,267,240
Brazil	132,107	22,979	5,514,070
Chile	67,186	36,572	3,053,160
China	60,491	.....	2,419,640
Cuba	38,550	2,324	1,565,240
Denmark	483,968	97,279	20,331,510
Netherlands	613,219	45,626	24,085,020
France	1,153,761	468,255	50,832,090
Germany	2,794,311	488,936	116,661,800
Greece	325,895	52,304	13,558,840
Italy	704,109	476,266	32,927,020
Japan	585,542	141,276	24,834,440
Mexico	15,210	3,678	645,180
Norway	935,220	718,511	44,594,270
Philippine Islands	43,138	8,261	1,808,130
Portugal	51,217	50,087	2,549,550
Roumania	16,600	634	670,340
Russia	578,343	231,305	25,446,770
Spain	720,822	43,625	29,269,130
Sweden	502,581	218,535	22,288,590
Turkey	92,869	61,625	4,331,010
United Kingdom	13,410,804	1,478,677	551,222,530
British Colonies	782,688	334,115	34,648,670
United States (exclud'g Lakes)	1,220,905	1,250,086	61,439,660
Uruguay	26,488	19,540	1,254,920
Other Countries	40,914	23,149	1,868,050
	26,182,293	6,329,903	$1,110,590,750

Foreign trade in breadstuffs and raw material is governed almost entirely by the natural law of supply and demand; consequently commercial nations are especially anxious to increase their exports of manufactured products, and no class of exports is so favorably affected as these by large foreign investments, intimate financial and banking relations with other countries, and commercial houses established abroad. These agencies are possessed plentifully by the old and great financial nations of Europe, but America is very deficient in them. In later years Germany especially has fully recognized their importance and advantage, and has devoted herself to strengthening greatly her commercial position in these respects.

The following table, however, shows surprising results in view of the advantages for the encouragement of foreign trade in manufactured articles which, it has just been stated, are possessed by Europe. It is equally surprising that the exports of manufactures from the United States in the period 1880-1900 have increased relatively two and one-half times as rapidly as its production of manufactures, which have enjoyed the stimulating effect of a protective tariff.

EXPORTS OF MANUFACTURED ARTICLES BY THE FOUR PRINCIPAL COMMERCIAL NATIONS. 1880—1890—1900.

COMPILED FROM STATISTICS OF BRITISH BOARD OF TRADE AND U. S. TREASURY DEPARTMENT.

YEARS.	UNITED KINGDOM.	UNITED STATES.	GERMANY. (Approx.)	FRANCE. (Approx.)
1880	$970,681,400	$102,856,015	$415,000,000	$370,000,000
1890	1,118,657,488	151,102,376	535,000,000	400,000,000
1900	1,142,602,562	433,851,756	745,000,000	450,000,000
Increase of 1900 over 1880	176,911,162	330,995,741	330,000,000	80,000,000
Per cent. of increase 1900 over 1880	11.54	321.66	79.52	21.62

EXPORTS AND IMPORTS OF RAW MATERIALS EMPLOYED IN MANUFACTURING BY THE FOUR PRINCIPAL COMMERCIAL NATIONS. 1890—1900.

PREPARED FROM BRITISH PARLIAMENTARY STATISTICS.

IMPORTS.

YEARS.	UNITED KINGDOM.	UNITED STATES. (Approx.)	GERMANY.	FRANCE.
1890	$752,881,725	$194,000,000	$446,000,000	$468,340,000
1900	878,112,225	280,381,000	700,750,000	757,060,000
Increase	125,230,500	86,381,000	254,750,000	288,720,000
Per cent.	16.6	44.5	54.9	61.7

EXPORTS.

1890	$107,703,260	$350,000,000	$177,500,000	$179,800,000
1900	209,395,000	459,250,000	277,750,000	216,960,000
Increase	101,691,740	109,250,000	100,250,000	37,160,000
Per cent.	94.1	23.8	56.5	20.6

This most remarkable increase of American exports of manufactures shown, is, in my opinion, attributable principally to the working

of natural economic laws rather than to extensive efforts toward expanding foreign trade. A glimpse should be given of the position of the four principal commercial nations as regards their position on the furnishing of raw materials for manufacturing purposes; hence the second table on the preceding page.

And now to review some of the differences between European and American conditions in practice.

The personnel of the staffs in the industrial concerns of the various countries in Europe, broadly speaking, may be said to be national for each country; yet industrial and commercial organizations are of necessity planned to secure international trade, for, in the words of Mr. Carnegie, "No one European country has a large homogeneous market."

In America, the reverse is the case in almost every particular. The personnel of the staffs of practically every large American concern is cosmopolitan; there, as nowhere else, are found associated men of many nationalities, possessing different racial characteristics and methods of thinking, widely varying education and experience—yet all working harmoniously for a common purpose, and thus uniting the more important elements essential to best conducting international trade. Nevertheless American organizations, with few exceptions, have paid little attention thereto, but have, quite naturally, devoted their principal efforts to securing business in that large homogeneous home market which is open to them.

The European is not generally an expert in creating a market or demand for new things, but he thoroughly understands the necessity of meeting the requirements of every existing market, and all the peculiarities incident thereto; he constantly does it, in a most admirable manner.

The American is expert in introducing new things and creating a demand therefor, as is evidenced by his success with sewing machines, typewriters, popular cameras, agricultural machinery, etc., abroad; but despite the fact that, as stated, he has at command the personnel, manufacturing methods, and natural resources to best meet the requirements and peculiarities of any market, he is usually inclined to the theory that American practice is right in everything, and that the foreigner can easily be convinced thereof; and he hesitates to furnish exactly what may be required by the foreigner, or to supply it in the manner in which it may be desired. He is surprised that the foreigner is seemingly obstinate in his theories, and forgets that this comes through traditions and familiarity with some certain practice,

or that, as is frequently the case, local conditions actually necessitate something at variance with ordinary American practice.

European industrial methods, laid out to meet the requirements of international trade, have hampered standardization, but have developed methods for the economical production of special work. American methods have produced the perfection of standardization, but have operated against the most economical production of special work. A happy combination of economical production on both these classes of work would, of course, be the ideal condition. Owing to his natural versatility, and his possession of the elements which he has at command, it is but natural to conclude that the American will reach this ideal when he is forced to do it through the necessities of trade.

The idea is generally prevalent in Europe that despite America's industrial success, the craftsman is disappearing in the United States. This may be true in those industries where he should disappear because of his former work being better accomplished in other ways; but in those industries where he should continue, America stands at the head of all nations, for she possesses the best talent from all.

In American manufacturing there is unquestionably carelessness in the use of raw materials, because they are generally cheap, while the highest possible efficiency is obtained from labor, because it is dear. In Europe, the reverse is the case. Great economy is manifested in the utilization of raw materials, because they are ordinarily dear, and very low efficiency is secured from labor, because it is cheap.

High efficiency of labor, with its corresponding high rates of wages, naturally increases the home consumption of manufactured products; while the most thorough utilization of power and attendant use of machinery, incident to high rates of labor, does on many articles reduce manufacturing costs to a lower figure than where time rates of labor are less. Conditions in the United States, illustrated by the tables opposite and subsequently compared with similar conditions elsewhere, demonstrate this feature, and illustrate the comparative extent of various markets for manufactured goods.

Complete statistics of similar character are not available for other countries in recent years; but "Mulhall's Industries and Wealth of Nations" 1895, gives most of the essential data up to that period, excepting as regards water power; certain exact figures upon various features involved are also available in recent publications of various Governments, so that reasonably approximate estimates can be made upon these conditions in countries other than the United States, for comparison therewith.

CONDITION OF MANUFACTURES IN THE UNITED STATES.

EMPLOYEES, PRODUCTION, AND POWER.

CENSUS, YEARS.	WAGE EARNERS.	VALUE OF PRODUCTS.	VALUE OF PRODUCTS PER WAGE EARNER.	PRODUCT PER CAPITA POPULATION.	TOTAL H. P. USED IN MANUFACTURING.	H. P. PER WAGE EARNER.
1880	2,732,595	$5,369,579,191	$1,946	$107	3,410,837	1.21
1890	4,251,613	9,372,437,283	2,204	150	5,954,655	1.40
1900	5,308,406	13,004,400,143	2,450	170	11,300,081	2.15

CONSUMPTION OF MANUFACTURES.

YEARS.	EXPORTS.	IMPORTS.	TOTAL MANUFACTURES CONSUMED IN U. S.	CONSUMPTION PER CAPITA POPULATION.
1880	$102,856,015	$268,333,432	$5,535,056,608	$110
1890	151,102,370	346,678,654	9,568,013,561	150
1900	433,851,756	315,060,916	12,885,609,303	169

It should be borne in mind, however, that the comparative number of artisans, or hand laborers, is much larger in European countries than in the United States, and that all such, with their products, are included in European statistics; but as it is not entirely so in the United States reports, the basis of comparison is not quite the same. The total of manufactures shown for European countries is proportionately higher than had the same rule been followed in computing them as in the United States, but the output and power used per wage earner are reduced under European practice in this respect. The effect of this is perhaps best illustrated by stating that in the United Kingdom, in 1900, there were approximately 4,000,000 people employed in workshops and factories, yet the total of those engaged in manufactures, including artisans, was not far from 9,000,000. If the power used in manufacturing were computed on only those employed in workshops and factories, it would average 3/4 of a horse power each, instead of 1/3 as in the table on the following page.

In Switzerland, in 1900, there were only 242,534 employed in factories, and 52,291 engaged in manufacturing at their homes; yet the total given in the table, including artisans employed in manufacturing, is 600,000.

Another feature which should be borne in mind is that the nature of a country's manufactured products and the prices prevailing thereon, may greatly affect their total or per capita output.

Despite the greater use of power and machinery in the United States as shown by the following tables, the proportionate manufacturing investment, strange to say, i. e., land, buildings, and machinery,

APPROXIMATE CONDITIONS OF MANUFACTURES IN VARIOUS COUNTRIES OF THE WORLD IN THE YEAR 1900.

Countries.	No. of Wage Earners.	Employees, Production and Power. Value of Manufactures.	Value of Products per Wage Earner.	Per Capita Population.	Total H. P. Used in Manufactures.	H. P. per Wage Earner.
United States	5,308,406	$13,004,400,143	$2,450	$170	11,300,081	2.15
United Kingdom	9,000,000	5,000,000,000	556	122	3,000,000	0.33
Germany	10,000,000	4,600,000,000	460	80	3,400,000	0.34
France	5,000,000	3,450,000,000	690	90	1,500,000	0.30
Belgium	1,550,000	720,000,000	480	110	630,000	0.42
Switzerland	600,000	300,000,000	500	106	320,431	0.54
Austria-Hungary	4,700,000	2,000,000,000	425	44	750,000	0.16
Russia	4,500,000	1,980,000,000	440	15	700,000	0.15
Italy	3,600,000	1,700,000,000	472	53	900,000	0.25
Norway	200,000	90,000,000	450	41	80,000	0.4
Sweden	490,000	280,000,000	572	56	200,000	0.41
Holland	460,000	245,000,000	540	49	130,000	0.29
Spain	1,800,000	650,000,000	361	38	250,000	0.15
Australia	550,000	500,000,000	900	90	460,000	0.80
Japan (Factories only)	388,298	220,000,000	566	5	84,816	0.22
Canada	550,000	800,000,000	1,455	146	750,000	1.36

as contrasted with the output of manufactures, is about the same as in France, Belgium and Switzerland; viz., a manufacturing investment equal to about one-third of the total annual production. In Germany it is believed that practically the same condition prevails. while in the United Kingdom the proportionate factory investment is considerably higher.

While the separation of manufactured articles produced in factories from those produced by artisans in Europe is an impossibility, it is believed that the average production per wage earner in the factories there is about 40 per cent. of the similar production in the United States, or say $980 per annum; and it is a liberal estimate to consider that one horse power is used per wage earner in European factories.

Considering the average annual compensation of the wage earner in European factories $170, which is one-half that paid in the United States, the figures

CONSUMPTION OF MANUFACTURES.

COUNTRIES.	POPULATION.	TOTAL MANUFACTURES CONSUMED.	APPROXIMATE CONSUMPTION PER CAPITA POPULATION.
United States	76,149,386	$12,885,609,303	$169
United Kingdom	41,000,000	4,273,397,438	104
Germany	56,367,000	4,152,450,000	74
France	38,700,000	3,168,000,000	82
Belgium	6,700,000	660,000,000	98
Switzerland	3,300,000	243,500,000	74
Austria-Hungary	45,405,267	1,900,000,000	42
Russia	128,900,000	2,000,000,000	16
Italy	32,100,000	1,714,000,000	53
Norway	2,200,000	115,000,000	52
Sweden	5,000,000	260,000,000	52
Holland	5,100,000	269,000,000	53
Spain	19,000,000	730,000,000	43
Australia	3,700,000	605,000,000	162
Japan	45,000,000	230,000,000	5
Canada	4,800,000	880,000,000	183

there being $340; and considering the average cost of generating power about $40 per annum on each continent, it is seen that in European factories the average percentage for labor and power on total cost of production is 21.4 per cent. In the United States it is 17.4 per cent. In view of this and of the well-known advantages possessed by the United States on nearly all classes of raw materials, no further arguments are considered necessary to demonstrate its strong position as a manufacturing nation, and its ability to compete for the world's trade on manufactured products.

The above tables also show conclusively that America itself is by far the best market of the world for manufactured products; consequently it is not strange that up to the present American manufacturers should have devoted their principal attention to home trade. Their success in foreign markets, so far, is attributable principally to their natural advantages already stated, and to the energy and ability of their representatives abroad.

When American manufacturers devote especial attention to meeting the requirements of each foreign nation; when the American ocean carrying trade is re-established; when American commercial houses exist everywhere; when America's growing wealth is more largely invested abroad; and when the country participates more thoroughly in international banking—then the amount of America's foreign trade will be more extensive than that of all Europe combined.

WAGE-PAYING METHODS FROM THE VIEWPOINT OF THE EMPLOYER.

By Henry Hess.

The question of the choice and adoption of a wage system is one of the most important in modern shop management. Mr. Hess's method of studying it goes to the foundations of the subject and takes account of all the elements entering the problem; at the same time it is thoroughly practical, in that it is addressed to working conditions and presented in graphic form, making the results instantly and clearly apparent. The paper is the second of three, taking up the advantages of the advanced wage systems from the viewpoint of the workman, the employer, and the invested capital.—THE EDITORS.

IN a previous paper, published in this Magazine for April, 1904, page 27, various methods of wage payment were considered from the workman's standpoint; it was assumed that, on the whole, the workman was inclined to render a fair equivalent in work for a fair payment, and that he would be stimulated to a fuller exercise of his powers of mind and muscle by a permanently assured increase of payment for his time. The feeling that such higher payments might be only temporarily granted by the employer, while the larger amount of work accomplished under its stimulus would be permanently exacted, was recognized as undeniably existent. The author's experience as a workman, manager, and employer has by no means shaken his belief that this attitude and the justification for it are not final; but its existence frequently proves pernicious in engendering a feeling of distrust and causing the adoption of safeguards that are only too often of a highly irritating nature. The final conclusion was reached that mutual self-interest might safely be relied on to bring about a unification along those lines that could be shown to be most clearly to the advantage of employer and employed; in other words, that system of wage payment that would result in the greatest return for his time to the workman, and the greatest profit on his product to the employer, would be certain of forcing itself to the fore, to the ultimate general welfare.

It is not lost sight of that the method of wage payment is but one incident in industrial production, as many other factors largely affect the costs; but as these all manifest themselves finally, so far as the relations between capital and labor are concerned, in the payment made to labor, that payment is the crucial element.

The various wage-paying methods considered are the old established day and piece plans, the Halsey premium plans and the Rowan modification, and finally the Gantt bonus system. In the first paper these were compared as to their relative value to the workman in amount of pay for his time when exerting himself to save time on the individual job or task. Chart 2 is reproduced on page 174 in graphic illustration of such values. Leaving out of consideration such psychologic elements as the fear that too great a wage would tempt the employer to a reduction, it was shown that, as regarded the wage rate per hour, for savings up to one-half time the Gantt bonus gave the highest return, and after that the ordinary piece work; at savings beyond one-half time these two changed places; next in order came the various premium plans with the Rowan modification in the lead, but caught up with and then passed by the Halsey 50 per cent. premium at one-half-time saving. Returns to the workman were least under day pay. For the poorer workman unable to save time, or actually taking more than that allowed, the earnings under all but the piece plan were alike and constant, while the latter penalized time losses by decreasing the hourly wage rate; this characteristic accounts for part of the disfavor with which piece work is viewed in most industries, notwithstanding the fact that it is of more universal application in the trades in general than any other method of payment.

Throughout this consideration, for want of a universally applicable norm, a wage-earning capacity of 25 cents per hour under day pay has been taken; the return in wages per hour has been assumed as equal for all methods in the base time of one hour allowed. In practice, piece-work rates are frequently established at an initial cut from the rate under day pay, in which case the returns would be relatively less than here shown; on the other hand, the introduction of the premium plan is often accompanied by an increase in the time allowance, the effect of which is a raising of the value to the workman above that shown. A certain study of the time required for day work is also often made use of in fixing the base time in piece and premium work; so far as the actual work of the machines themselves is concerned, this is often fairly correct. Mr. Taylor was the first to study systematically the possibilities along this entire line and he finds that much shorter times than are usually considered possible could be realized without undue exertion. In order to provide the necessary stimulus for turning out the much larger amount of work, Mr. Gantt starts in with a large bonus for the attainment of the time set, resulting in a decidedly higher wage return per hour.

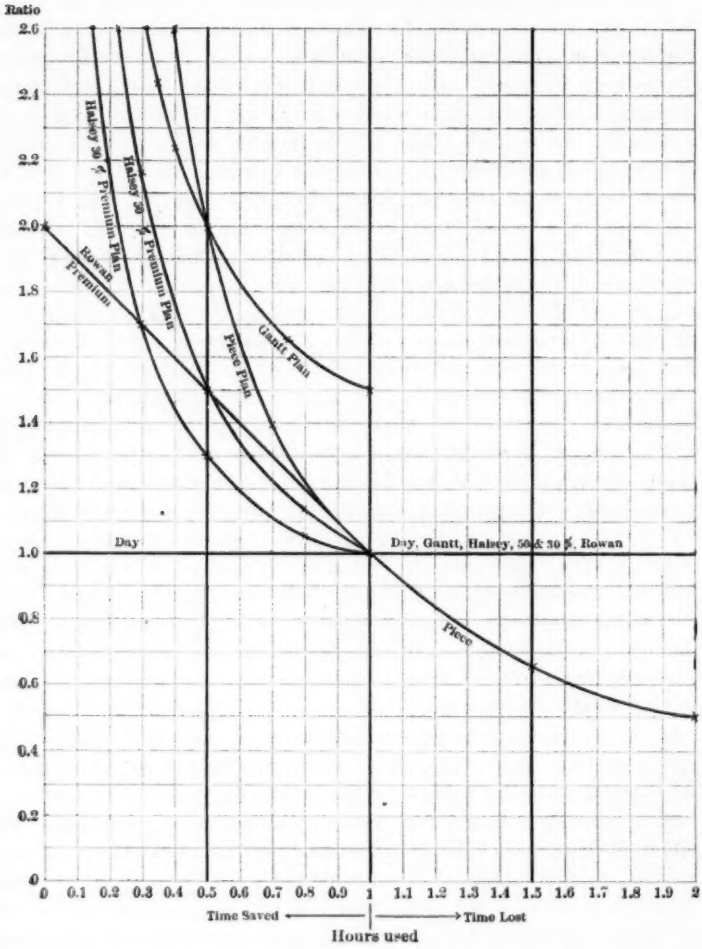


CHART 2. RELATIVE VALUE TO THE WORKMAN OF VARIOUS METHODS OF WAGE PAYMENT, AS COMPARED WITH DAY PAY.

The horizontal scale shows the hours used, with one hour as the time set as a basis in the center of the scale and shown by a solid vertical line; time saved and lost lie to the left and right of this; the region of most likely results, that is time savings and losses of one-half, are included between the outer heavy lines; the vertical scale at the left gives the relative values as ratios to day pay as unity.

In the following consideration the objective of the manager is considered to be the attainment of the highest profit as compared with

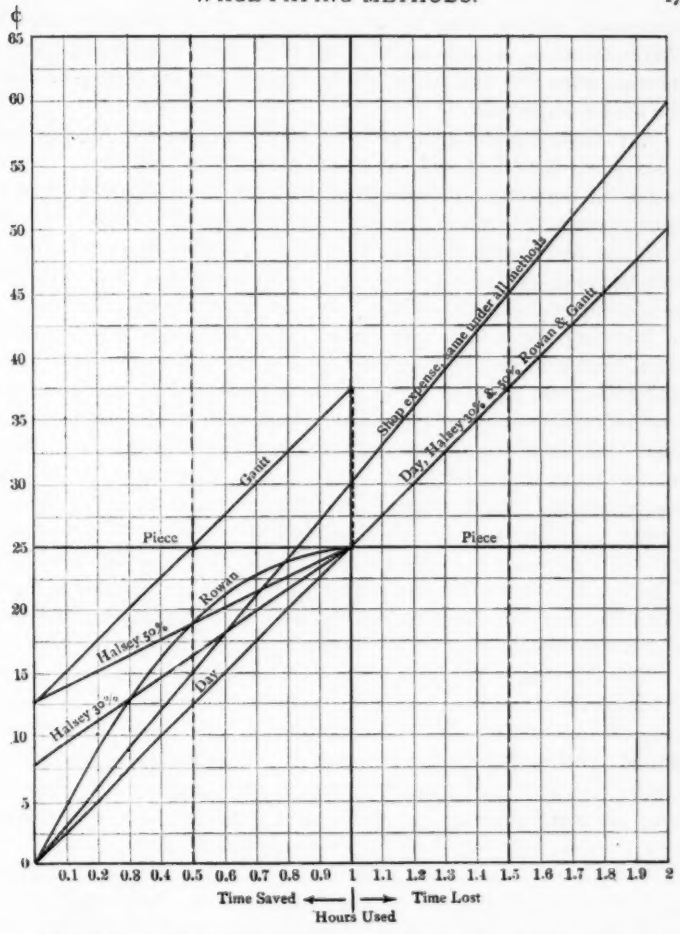


CHART 3. WAGES COST BY VARIOUS METHODS OF WAGE PAYMENT.

his total costs. The various elements affecting this are compared first singly and then collectively; their characteristics are illustrated as curves and lines referred to the hours used, in the same way as previously explained for Chart 2, to show what influence time savings and losses by the workmen exert on the various costs, and finally on the profits. The base line of all the charts is therefore the same.

Chart 3 refers to wage costs, and shows these to be constant for

piece work whether time be saved or lost; all of the other plans are characterized by a decrease of wage costs with time savings and an increase attending time losses. When time is lost the piece plan shows the lowest wage cost.

Mr. Gantt's bonus plan and the piece plan give the highest wage costs when time is saved; were the assumption true that the wage cost alone correctly measures the value of the various plans, then the later systems, as well as the piece plan, would all be inferior to day work, as that shows the lowest wage cost. This is, in fact, a contention upheld by not a few. It is not surprising that those who compute costs on this basis see the chief possibility toward cost reduction in lowering the hourly wage rate; the great majority of workmen are so accustomed to hearing the expenses based directly on the wages, that they must logically come to the conclusion that any attempt at cost reduction necessarily involves a reduction in their hourly earnings. But aside from wage-cost, time is an element that has a direct money value in manufacturing operations; that value is variously recognized as "shop expense, burden, oncost," etc.; though frequently considered as directly proportional to the wage cost, particularly so by the older school of accountants, the closer study of latter years has shown it to be very nearly proportional to the time occupied. Were the first consideration correct, then it would confirm the wage cost as the correct measure of the value of any wage-paying plan.

The fact that shop expense is an element dependent upon time, and not properly chargeable as a direct ratio of the wage cost, is now so generally recognized that all argument in proof may be here dispensed with and only its influence in the concrete be considered. Shop expense in well managed machine shops will rarely exceed 30 cents per hour; the diagonal in the chart marked "expense" is characteristic of its influence with varying amounts of time.

Chart 4 gives the sum of wages cost *plus* expense in direct amounts under the various methods of wage payment, and shows that so long as the base time is not exceeded the advantage lies with day pay, with the Halsey 30-per cent. premium plan a close second; the Halsey 50-per cent. and Rowan premium plans come next in order, the Rowan changing places with the Halsey 50-per cent. at and beyond time savings of one-half, and with the Halsey 30-per cent. as soon as less than 0.3 time is used; it finally coincides with the results of day pay when all the time is saved. It takes time savings of fully one half to make the Gantt plan cost no more than piece work, and still greater savings to give it an advantage over that. It is obvious that the

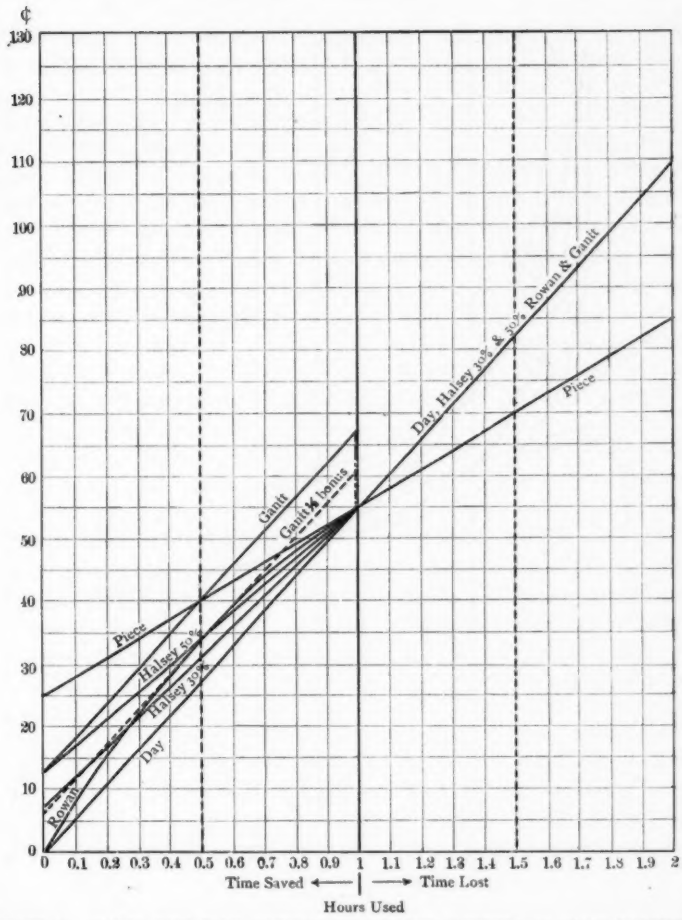


CHART 4. WAGES COST PLUS EXPENSE BY VARIOUS METHODS OF WAGE PAYMENT.

bonus of the Gantt plan is too high; were that reduced by one-half, it would better the total cost as compared with the Halsey 50-per cent., but not before a time saving of over one-half was made; it would then better the results of piece work at a time saving of over one-fourth; the corresponding line is dotted in on the chart. If no time is saved, the advantage lies with piece work as against all of the other plans, which are then of equal value as among themselves.

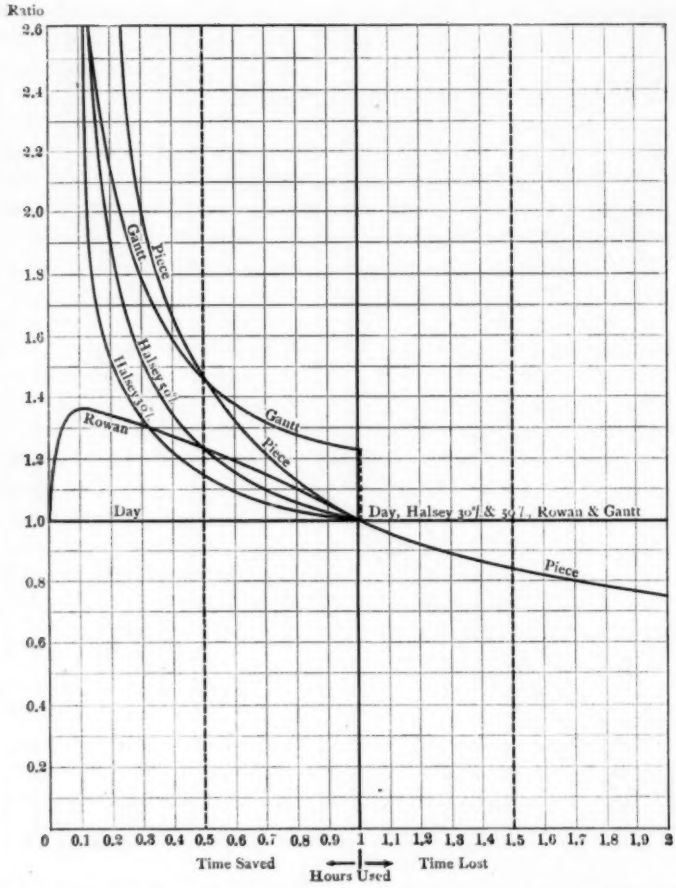


CHART 5. RELATIVE WAGES COST PLUS EXPENSE BY VARIOUS METHODS OF WAGE PAYMENT, COMPARED WITH DAY PAY.

The relative value of the various plans is shown still more clearly by a consideration of their ratios; Chart 5 illustrates this with day pay taken as unity. It shows absolutely that day pay gives the lowest cost whenever time is saved. Within the region of reasonably-to-be-expected time savings, up to one-half, the Halsey at 30 per cent. most nearly approaches it. The logical conclusion is that to keep

down wage cost *plus* expense total, day pay should be employed, provided that under it the men can be induced to put forth nearly equal efforts towards saving time. If a stimulus in the direction of increased earnings for increased effort is needed, the Halsey 30-per cent. and after that the Halsey 50-per cent. and the Rowan premium plans deserve consideration. The advantage possessed by the piece plan in giving the lowest total costs when time is lost may be disregarded; no adequate management will permit the condition of time losses often enough to allow it to count as a material factor.

The works manager's or employer's interest does not, however, cease when he has brought his wages cost *plus* expense down as low as possible; at least, not if he is interested in sales and profits. The cost of material must be added to wages and expense to get the total cost. It is assumed that selling expense is included in the shop expense, or that such part as is not so included is added directly to the selling price; this consideration was influential in setting the expense at the rather high rate of 30 cents per hour.

It is clear that the material cost will be constant, and independent of the variation in wage and expense cost due to time savings or losses; assuming it at 40 cents in industries having a day-pay rate of 25 cents per hour will answer fairly well. Chart 6 represents the conditions under day pay. It contains diagonal lines giving wages cost and expense cost, a horizontal line giving the material cost, and a diagonal line giving the total cost; this latter is made up directly from the summation of the cost elements mentioned. The selling price will most likely be fixed by competitive market conditions at, say, 100 cents, and will of course then be constant, independent of the gain or loss in time from the base time allowed for the work; a corresponding horizontal line is entered in the chart. So long as that line is above the diagonal representing total cost, a profit is realized; when the total costs rise above, a loss is recorded. In this particular instance, the change from profit to loss is made when, instead of the base time allowed of 1 hour, 1.1 hours are actually used—a rather close margin unless there is a certainty of time savings being made. In order to emphasize this, the area between the selling price and total cost lines is shaded, throwing the profit and loss regions more distinctly into relief. The curved lines on the chart show the profit and loss figured out as a percentage of the total costs.

The line representing the actual wages rate per hour to the workman is also inserted, in order to complete the presentation on one chart of all of the various elements of the problem. Charts 7, 8, 9, 10 and

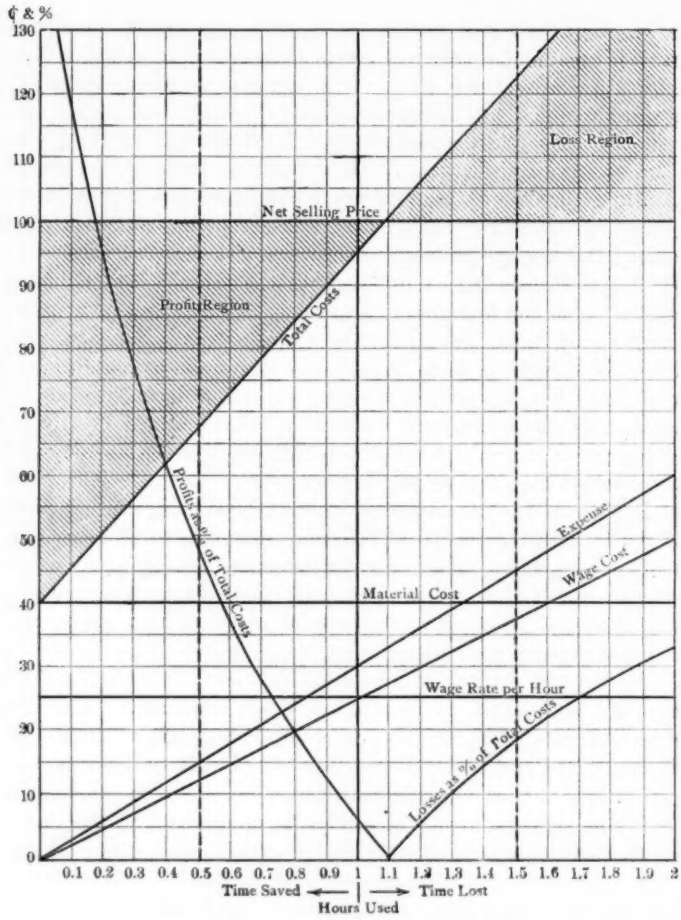


CHART 6. PROFIT AND LOSS BY DAY PAY.

11 are of the same character and relate to the Halsey 30-per cent. and 50-per cent. and the Rowan premium plans, the piece-work system, and the Gantt bonus method. It is evident that that plan is best that shows the largest profit area within the reasonably-to-be-expected time savings up to one-half. Such comparison will show the advantage to lie in the order in which the charts follow, day pay leading.

Piece work, Chart, 10, has a slight advantage under time losses

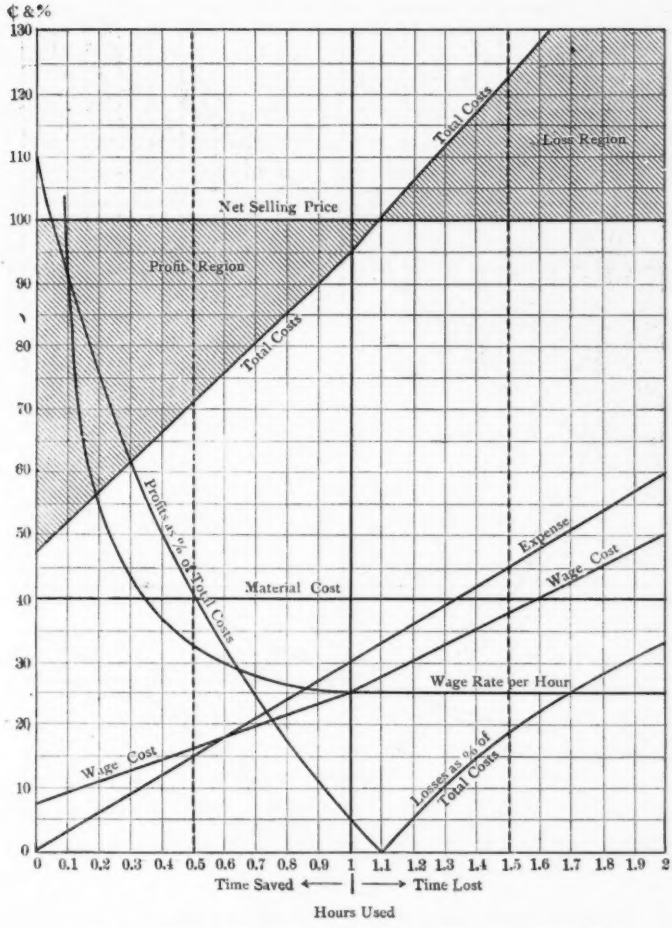


CHART 7. PROFIT AND LOSS BY HALSEY 30-PER CENT. PREMIUM.

in that the crossing of the total cost and selling lines occurs at a somewhat larger time loss—i. e., when 1.17 hours are occupied, in place of 1.1 as with all other plans except the Gantt. A comparison of the loss areas also shows that for piece work to be decidedly the smaller, but the difference is not sufficiently great to compensate for the advantages of the other methods on the time-savings side. The existence of such a difference, however, leads logically to the con-

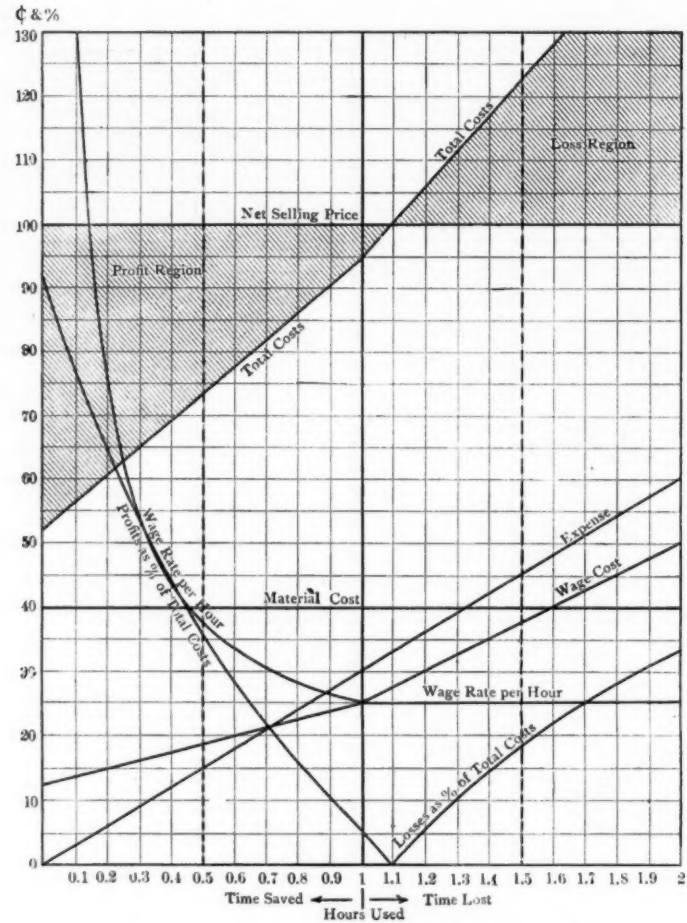


CHART 8. PROFIT AND LOSS BY HALSEY 50-PER CENT. PREMIUM.

sideration of the advisability of adopting a fixed price for the piece in case time is lost, combined with, say, the Halsey 30-per cent. premium plan for time savings, provided such proposal does not meet with too strenuous objections from the workmen. As it should be the aim of good management to make time losses average very few, much stress is not to be laid on this phase of the situation.

Chart 11 of the Gantt plan shows a loss beginning in the region

of time savings at 0.87 hour, emphasizing still further the conclusion already arrived at—that it is inadvisable to provide too high a bonus. The effect of the sudden change from such a high bonus to the day rate when no time is saved, manifests itself somewhat paradoxically in reintroducing a short region of profit between time used of 1 and 1.1 hours, so that unless sufficient time is saved to occupy only 0.87 hour it is better to lose time to the extent of taking up 1.1 hours.

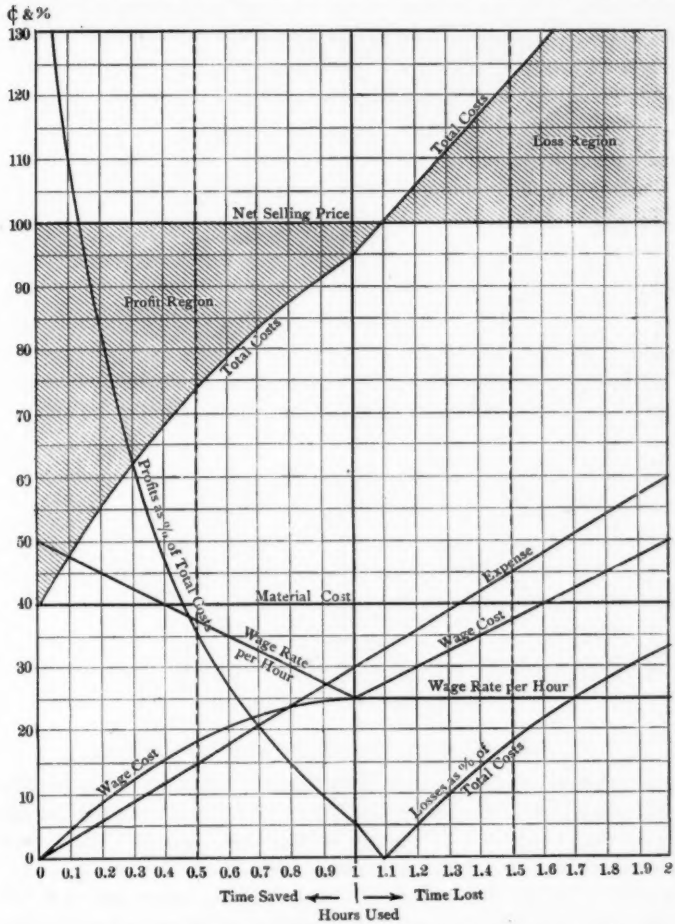


CHART 9. PROFIT AND LOSS BY ROWAN PREMIUM.

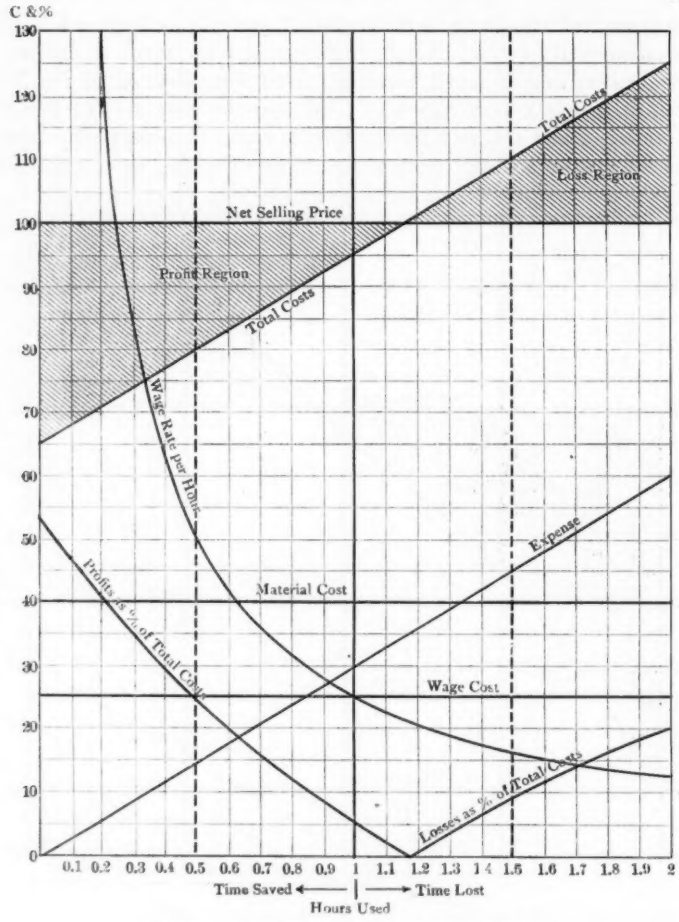


CHART 10. PROFIT AND LOSS BY PIECE WORK.

The relative values of the various plans as influencing the profits are still more clearly shown on Chart 12; data taken from the curves that give the profits as a percentage of the total costs on Charts 6 to 11 are plotted as ratios to the percentage of profits by day pay as unity. With only 0.8 hour of the base time occupied, the values are as 1 for day pay, 0.91 for Halsey 30-per cent., 0.85 for Halsey 50-per cent., 0.82 for Rowan, 0.66 for piece work, and 0.20 for Gantt. Crossings

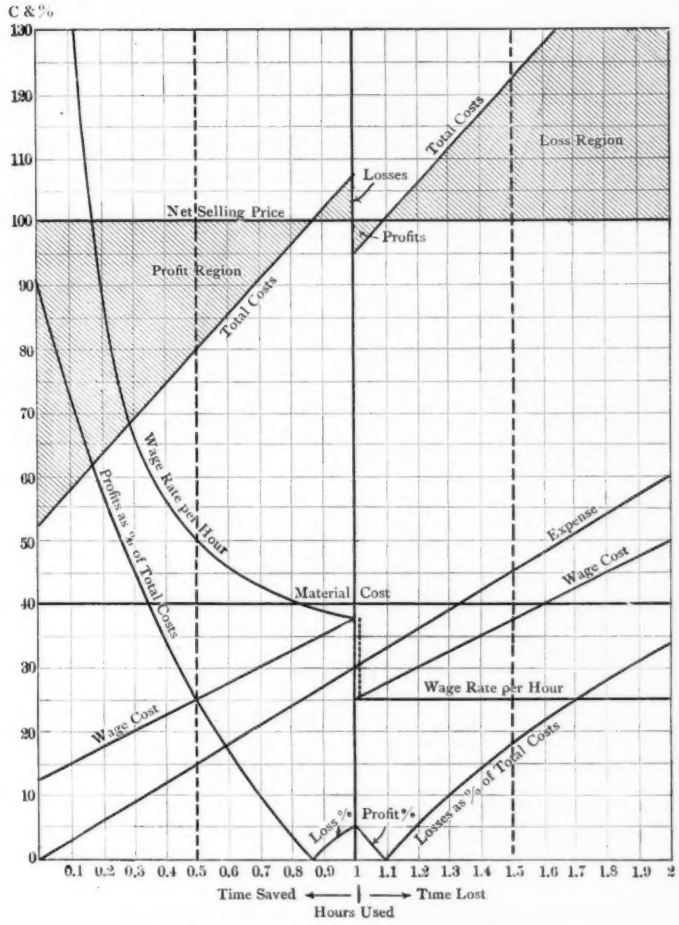


CHART II. PROFIT AND LOSS BY GANTT BONUS.

of the curves indicate equality of the methods at certain time savings; for instance, with 0.3 hour occupied, the Rowan and Halsey 30-per cent. premium plan are of equal value.

The results in profits will naturally vary with the cost of shop expense and material as compared with the basic labor value, and so necessitate a careful consideration of these various elements before arriving at a definite conclusion as to the method of wage apportion-

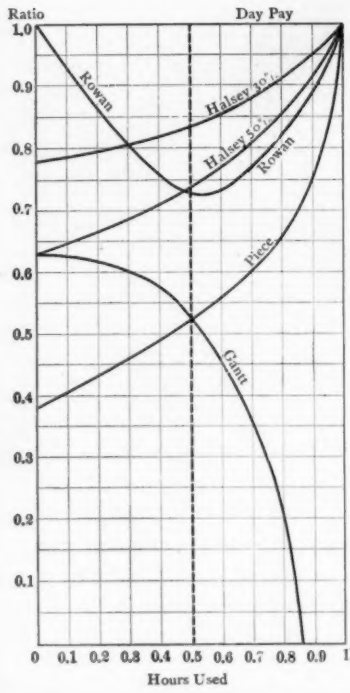
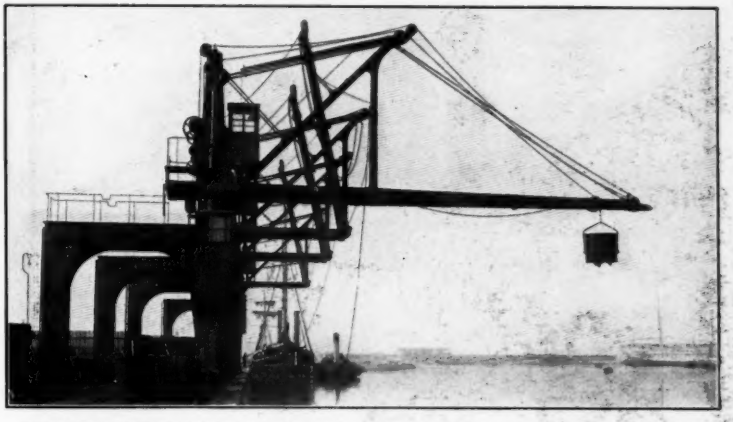


CHART 12. RELATIVE PROFITS BY TIME SAVING UNDER VARIOUS METHODS OF WAGE PAYMENT, COMPARED WITH DAY PAY.

ment to be adopted. Under conditions similar to those here assumed, which may be taken as fairly representative of a large line of machine industries, the general conclusion to be drawn is that profits will be best under day pay, even when under that method not quite as large time savings can be brought about as under the others. Next in order is the Halsey 30-per cent. premium plan; the stimulus it provides is probably sufficient wherever such saving is mainly a question of harder machine driving. In industries in which the output is chiefly dependent upon machinery, day pay is to be advocated as resulting in higher profits, providing that the attendants do not hold the machines down much below their maximum capacity. If that is to be expected—and with the prevalent attitude of organized labor it usually is—the premium plan is again the better, and has also the advantage of acceptance by some unions and the sympathetic approval of others. Piece work is distasteful to labor, and for the manager lies under the disadvantage of giving relatively low profit returns, as shown on Chart 12. The Gantt bonus method with the high bonus advocated gives entirely too poor returns in profits;* reducing the bonus betters the plan in this respect until with the bonus equal zero it is merged in and identical with the day-pay plan.

The effect of these various wage-paying methods from the viewpoint of the investor, as affecting the total capital employed and the interest returns on it, will be considered in the concluding article.

* It is true that its advocates use it only in conjunction with certain highly developed methods of intensifying output; but the favorable returns are then rather to the credit of such methods; even then, with a bonus of 50 per cent. of the day pay, the profits have the value of the Halsey 50-per cent. plan, and only when no time at all is taken, as shown by the coincidence of the Gantt and Halsey 50-per cent. curves at that time on Chart 12.



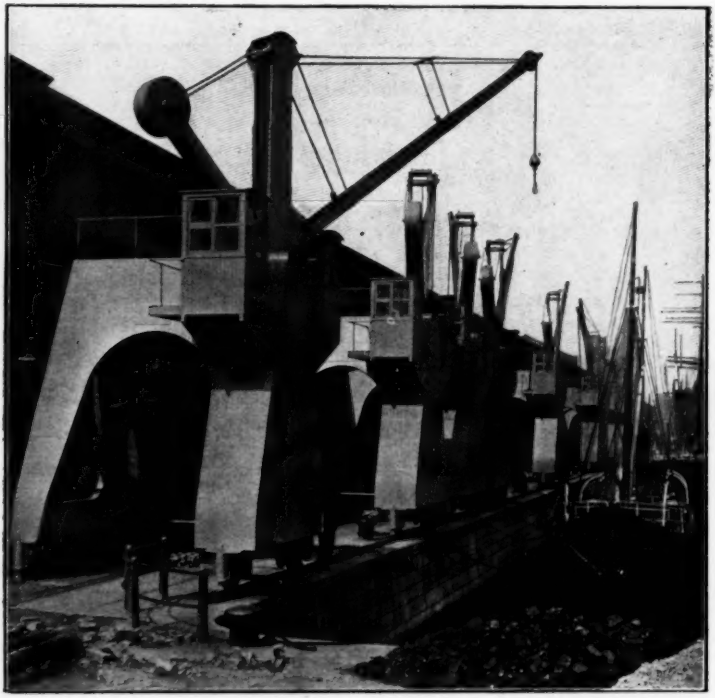
HYDRAULIC WEIGHING CRANE, FOR DISCHARGING CARGO OVERSIDE OR INTO TRUCKS
Sir W. G. Armstrong, Whitworth & Co.

HYDRAULIC CRANES AND WHARF MACHINERY.

By George H. Baxter.

Mr. Baxter's review began in the special Labor-Saving Number of THE ENGINEERING MAGAZINE, published in March last. The extent of the subject and the illustration, even in this specialized field of hydraulic power applications, limited it there to coaling machinery. The present article takes up the allied subject of cranes and other wharf machinery.—THE EDITORS.

HYDRAULIC wharf cranes for dealing with ore and general cargo are almost entirely worked by rams and multiplying pulleys, both for hoisting and turning. They vary much in design to suit special circumstances, and are arranged sometimes on the quay, or sometimes on the roofs and walls of warehouses, and they may be either fixed or movable, with fixed or luffing jibs. Many steamships are also provided with cranes worked by hydraulic power. The illustration on the next page shows a row of nine 35-hundredweight movable "portal" cranes made by Fullarton, Hodgart & Barclay, Ltd., Paisley, for the Princes Dock in 1894 for handling general cargo. The pedestal is formed to admit of wagons and locomotives passing underneath and contains the hoisting and slewing cylinders. They have a lifting range of 65 feet, the jib-head pulley being 41 feet above the quay. The rake is 29½ feet and the hook projects 27½ feet beyond the face of the



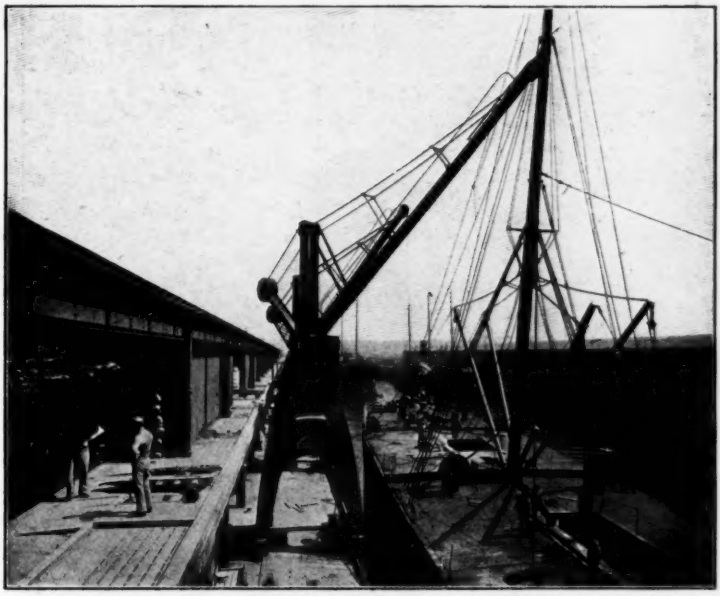
A ROW OF 35-HUNDREDWEIGHT MOVABLE PORTAL CRANES, PRINCES DOCK, GLASGOW.

quay. Hand gear is provided on each crane for travelling it along the quay, although more frequently capstans having a pulling stress of over one ton are used for this purpose. The illustration on the opposite page shows a 2-ton crane of somewhat similar type, giving also a view of the interior of one of the large double-floor sheds on the quays at Princes Dock. These cranes, of which there are eight, are by the same makers, but of larger dimensions, the range of lift being 75 feet, while the jib-head pulley is 60 feet above quay level, and the rake is 41 feet to meet the requirements of larger vessels.

There are a large number of "compound" or double-power hydraulic cranes having the same range, rake, and height as the 2-ton cranes but constructed with a ram capable of lifting loads of 5 tons. A smaller ram slides inside the 5-ton ram, which has a stuffing box at the upper end, and is adapted to lift loads of 2 tons in cranes used for general cargo, and 3 tons in cranes for discharging ore. When the

smaller ram, which carries the crosshead with multiplying pulleys, is used, the large ram is held down by stoppers which are removed when the 5-ton ram is required. The heavier lift is provided to avoid the necessity of having to move a vessel to another crane in-case of having to deal with any pieces over 2 or 3 and up to 5 tons.

Another type of movable crane, triple-power, is shown in the photograph on page 190. In this crane the vertical leg of the pedestal rests on rails at the edge of the quay, and the back of the horizontal portion on rails at the edge of a balcony or gangway next the wall of the warehouse and level with the first floor. This crane is made to lift loads of 15 hundred weight and 30 hundred weight respectively to a height of 90 feet, and from a pulley half-way up the jib, with a gin block giving a double purchase, can lift 3 tons 45 feet at a reduced speed.



TWO-TON MOVABLE HYDRAULIC DOCK CRANE, PRINCES DOCK, GLASGOW.
Fullarton, Hodgart & Barclay, Ltd.

All cranes of the designs referred to above have the hoisting and turning cylinders and most of the piping housed inside the pedestals, which in winter are heated by gas, when required to prevent damage by frost. Each has a fixed cabin on each side of the pedestal, with a set of handles for working the pressure and return valves of the hoisting

and turning rams, the cabin used being the one most convenient for the driver seeing the loads when working the crane. The compound 5 and 2-ton and 5 and 3-ton cranes are each provided with a hydraulic motor and gearing for travelling them along the quays. Pressure water is led to the cranes by walking pipes, or by hydraulic hose piping with special couplings, and the return water is conducted from the cranes by armoured rubber and canvas hose with couplings connected to the most convenient hydrant box. All the cranes are rapid in their movements and can lift ore or general cargo as fast as it can be brought within the range of the hook.

Where sheds or warehouses are within a few feet of the quay edge,

TRIPLE-POWER MOVABLE CRANE. ONE FOOT ON THE QUAY AND ONE ON WAREHOUSE BALCONY.
Fullarton, Hodgart & Barclay, Ltd., Paisley.

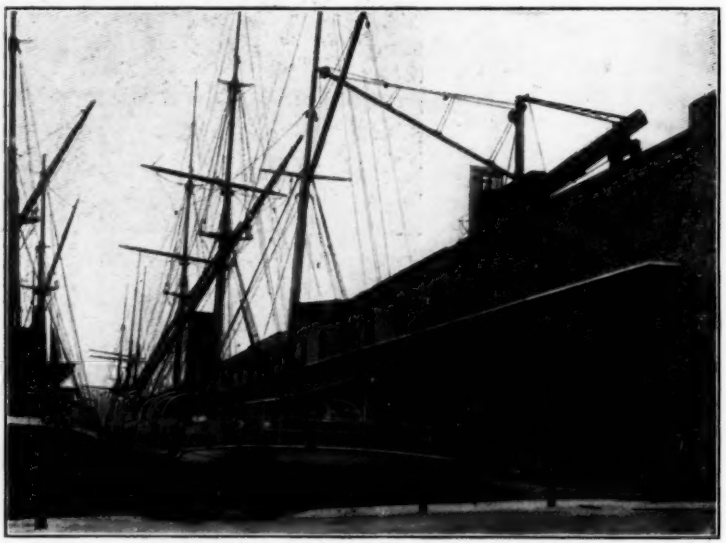
the cranes are frequently designed to travel along the roof, as shown in the photograph on page 192, a system largely adopted at the Liverpool docks. In such cranes the hoisting rams and pulleys are usually arranged in the plate-iron box lying on the slope of the roof, and the turning rams in the longitudinal box. It need scarcely be said that the walls and roof of such buildings require to be specially constructed to sustain the weight of a number of such cranes with their loads and counterbalance weights. The Liverpool cranes shown are constructed to lift loads of 30 hundredweight to a height of 76 feet and are travelled along the roof to any position by hand gearing. Another type known as the "balcony" crane is shown on this page. Such cranes are carried on rails fixed to the walls of the warehouse high enough up to clear all shipping.

HYDRAULIC BALCONY CRANE.

At Irongate and St. Katharine's wharves of the General Steam Navigation Company at Deptford there are a set of seven balcony cranes made by Messrs. Fielding & Platt, Ltd., Gloucester, and shown on page 192. Six of these are 30-hundredweight cranes having a maximum radius of 65 feet, a minimum radius of 20 feet, and 75 feet range of lift. Each is fitted with hydraulic lifting, slewing, and luffing motions, and Fielding's patent compensating balance gear giving economy of power and smoothness of working, and another patent arrangement whereby the load is carried at about the same level

BALCONY CRANES, DEPTFORD WHARVES OF THE GENERAL STEAM NAVIGATION CO.
Six 30-cwt. and one 60-cwt. Fielding & Platt, Ltd., Gloucester.

throughout the entire range of the luffing movement. The remaining crane is similar to the others but capable of lifting 3 tons or 30 hundredweight as desired. The illustrations show one of the cranes luffed out to its utmost extent, clearing one vessel and taking goods from the

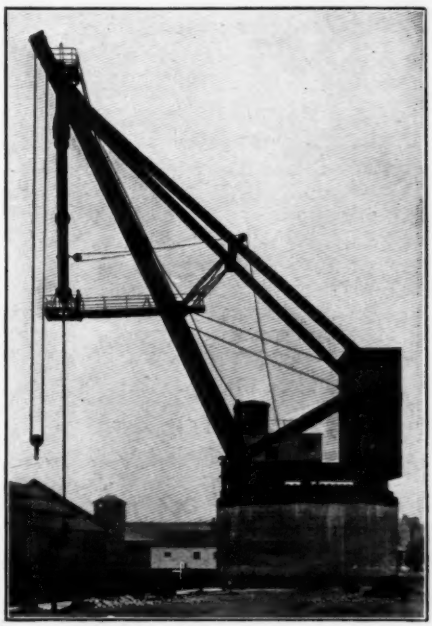


HYDRAULIC CRANE TRAVELLING ON WAREHOUSE ROOF ("SPARROW CRANE"), LIVERPOOL DOCKS.
Sir W. G. Armstrong, Whitworth & Co.

hold of another lying alongside, which will give some idea of the range and capacity of this installation.

An important feature of these balcony cranes is that the whole of the working gear is supported and contained by a steel framework outside the warehouse wall, thus avoiding the waste of storage space inside and the risk of damage to goods by water.

The illustration at the head of this article shows a rather uncommon type of movable hydraulic crane chiefly used for discharging coal, ore, etc., from ships and delivering it overside or into trucks on the quay, the loads being in either case weighted by steelyard on the jib. For delivering overside, a hinged extension jib is used which is turned up out of the way when delivering on the quay, for which purpose the cranes have a turning movement.



100-TON HYDRAULIC CRANE, LIVERPOOL.

The photograph on this page shows a large hydraulic crane erected at Liverpool by Sir W. G. Armstrong, Whitworth & Co., Ltd. It is capable of lifting 100 tons by means of a direct-acting cylinder suspended from the end of the jib, the range of lift being 50 feet. When more height or length of lift is required for masting ships, the chain purchase beyond the cylinder is used. The lifting power of this purchase is usually 30 tons and the range of lift 80 feet. The crane is mounted on live rollers and is turned by a hydraulic engine. Similar cranes are being erected at Spezia, Malta, Bombay, Venice, and at one of the Government dockyards in Japan.

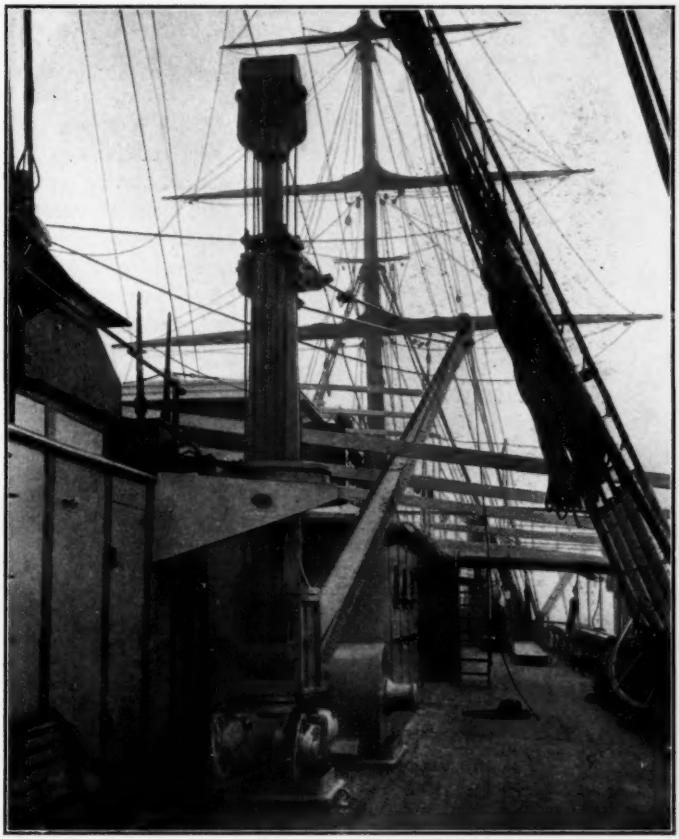
A 30-ton movable hydraulic crane specially designed for graving dock use is shown in the photograph on the page following. It is so constructed that it serves two docks lying alongside one another. At

the end of its path is a semi-circular track round which it is moved when required for use at the adjacent dock.

Hydraulic cranes are frequently provided on passenger ships in place of steam cranes, being so much cleaner and perfectly noiseless. All the larger Peninsular and Oriental steamers and similar vessels are equipped with such cranes, of which illustrations are given showing how they are arranged on shipboard. In this design the hoisting cylinder is utilised to form the mast of the crane, the middle bearing being arranged in a cast-iron sole fixed to the upper deck. The jib stays are secured to pins at the top of the cylinder and can be unshipped so as to admit of the jib being lowered down on the deck if required. The turning cylinders are arranged close down to the deck and the whole design is very compact and simple. By the multiple pulleys the hook is raised 10 feet for every foot stroke of the ram, thus admitting of a large range of lift. The handles for working the valves are most conveniently arranged on the upper deck, from whence the driver can see the load as it comes up the hatch.

Where such power is available hydraulic bollards or capstans with horizontal heads are frequently used on board ship and in special cases for land service also. The heads, which are of different

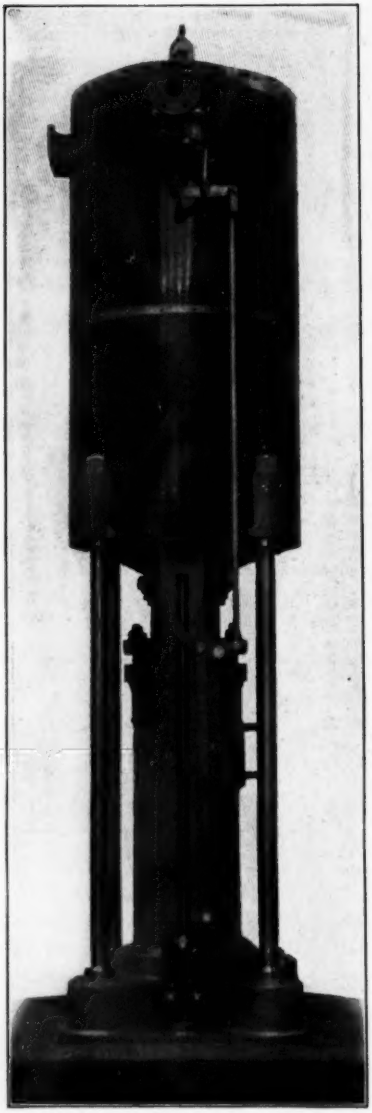
30-TON MOVABLE HYDRAULIC CRANE, FOR SERVING TWO GRAVING DOCKS.



HYDRAULIC CRANE INSTALLED ON SHIPBOARD, P. & O. STEAMER.

diameters to give two speeds, are mounted on the ends of a crank shaft driven by a three-cylinder hydraulic engine, the rams of which work on a common crank pin. The greater portion of one side of the engine casing is made removable to give access for examination and repair. This is a most useful appliance, very suitable for the many kinds of haulage work required on board a large steamer.

The ordinary loaded accumulator as used on land is unsuitable for steamships; such a weight sliding up and down in a vessel rolling about in a sea way would be quite impracticable. The hydraulic accumulator used at sea is loaded by steam to any required pressure. One of



STEAM-LOADED HYDRAULIC ACCUMULATOR FOR MARINE USE.
Fullarton, Hodgart & Barclay, Ltd.

these is illustrated on this page. It will be seen that the steam cylinder is mounted on four columns secured to the sole plate. It has a spring-packed piston, top and bottom buffer springs, safety valve, etc. The piston rod, usually of cast iron, is prolonged through the stuffing box and serves as a ram for the hydraulic cylinder which is bolted to the sole plate directly underneath the steam cylinder.

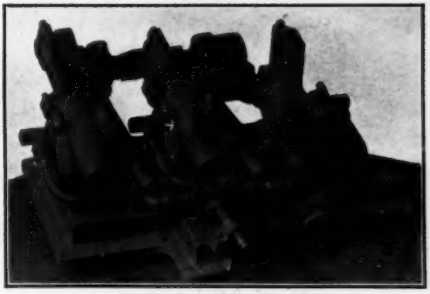
Another application of hydraulic power on board ship is illustrated in the engraving on page 200, where a hopper barge is shown fitted with hydraulic cranes working grabs for dredging. This description of dredger is very useful for working in confined spaces in docks and basins where a dredger of the bucket or suction type could not be worked. The hopper is filled with spoil brought up by the grabs, and the barge is then taken to sea, where the material is deposited.

The picture on page 199 shows a movable hydraulic jigger hoist for discharging light cargo from ships and making up lifts ready for cranes. It is a simple appliance, consisting of a cylinder and ram with multiple pulleys working a chain, one end of which is fixed and the other wound round a barrel connected with a rather

large narrow drum on which a wire rope is wound and led over a pulley to the hold of the vessel. The whole is mounted on a carriage with wheels, so that it is easily transported wherever required. The wire rope moves about 16 feet for each foot of the ram.

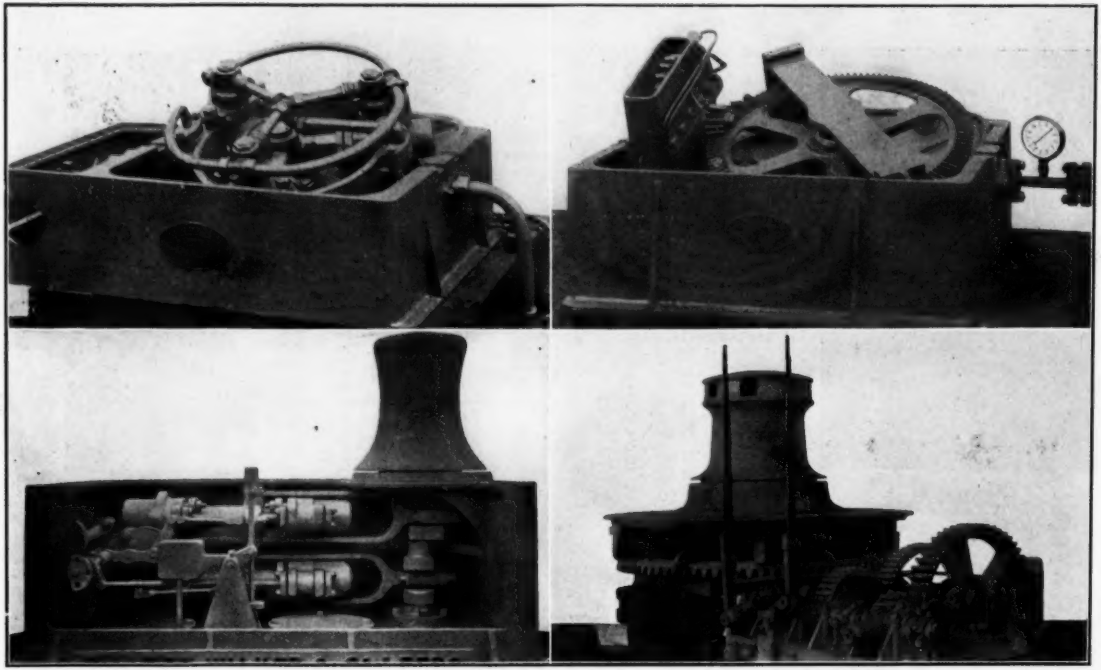
HYDRAULIC TURN-OVER CAPSTAN, CENTRAL-VALVE TYPE.

Capstans. — Many capstans are used for hauling wagons, etc., on dock mineral quays, at coaling berths, and on lines of railway leading thereto, and also at many railway goods yards. The photograph here shows a capstan very commonly used for these purposes; it is of the turn-over type, made by the Elswick firm, and is most convenient for access for overhauling. In this design there are three cylinders oscillating in trunnion bearings in the base plate, the there rams of which act on the crank pin, driving the capstan head which is securely fastened to the crank shaft by a strong key and a left handed screw nut. A flat circular valve, central with the crank shaft, is worked by it, admitting pressure and releasing exhaust water to and from each separate cylinder. The base plate is supported on two trunnions working in bearings in the framing. Stuffing boxes are fitted to the outside ends of the trunnions, the water entering through one end, passing through the cylinders, and exhausting at the other end. The base plate can turn a complete revolution, thus exposing all the working parts. In some cases (and it is a very desirable adjunct for turning the base-plate) a worm and quadrant are fitted, which also serve the purpose of locking the base-plate in any position. When working, the latter is securely locked to the



THREE-CYLINDER ROTARY HYDRAULIC ENGINE.

The cylinders oscillate in trunnion bearings, the valves being worked by cranks cast on the trunnions.
Sir W. G. Armstrong, Whitworth & Co.

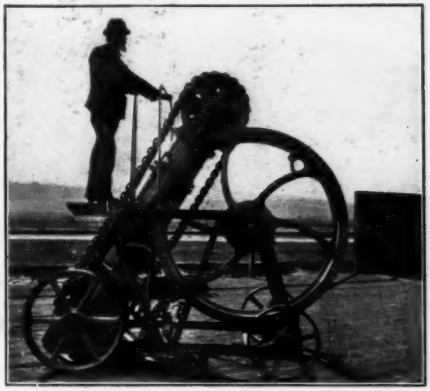


TYPES OF HYDRAULIC CAPSTANS, OF FIXED AND TURN-OVER DESIGNS.

The upper left figure shows a capstan by the Glenfield Co., with admission and release of water through a valve chest bolted to the end of one trunnion. The other turn-over capstan, to the right, is by the same makers. This is driven by a Pelton wheel, as described on page 199. Below to the left is the Tannett, Walker & Co. four-cylinder capstan described on page 199, and to the right of that the 11-ton Elswick geared capstan for hauling vessels in and out of docks.

frame with iron catches. In another design of turn-over capstan, it will be seen from the photograph that the admission and release of water to each cylinder is regulated by a gun-metal valve working in a valve chest bolted to the end of one of its trunnions. The consumption of water by these capstans is 1.087 gallons per revolution.

Another design of turn-over capstan is the one shown by the photograph on page 198, worked by a Pelton wheel and gearing. The supply of pressure water is regulated by two nozzles, either or both of which may be used according to the pull required on the capstan. The consumption of pressure water at full power is much the same as the capstans previously described but, for obvious reasons, in place of the water being returned to the pumping station after being used by the wheel it is run into the dock. One disadvantage of these capstans, for rapid working, is the slight delay caused by the acceleration required by the Pelton wheel at starting. One considerable advantage, however, is that the upkeep is somewhat less; the water used at half power is also much less, and again, in isolated positions where a capstan may be only occasionally required, it is always ready for use, but when the three-cylinder type have to stand idle for any length of time the cup leathers are apt to get dry and leak when the capstan is most wanted. The Pelton wheel is 18 inches diameter and the speed 2,000 revolutions per minute, the speed of the capstan head is 80 revolutions per minute, the two jets are 3-16-inch diameter, and the pressure normally is about 700 pounds per square inch. Another well-known type of capstan, much adopted throughout the docks and railway yards of Great Britain, is the four-ram hydraulic railway capstan of which a large number have been made by Tannett, Walker & Co., Ltd., of Leeds. In this design there are, as shown by the photograph, two pairs of single-acting rams, each pair acting on one crank pin at right angles with the other. The upper pair of rams actuate the valve gear for regulating the admission and release of



MOVABLE HYDRAULIC JIGGER HOIST FOR LIGHT CARGO.

water to the lower, which, in turn, work the valve gear of the upper pair of rams. The arrangement is very simple and compact and the light chequered wrought-iron plates on top are made removable to give access to the working parts for overhauling. The pulling power is one ton and the consumption of water at 750 pounds pressure, like the others, is 78 gallons per revolution.

HOPPER BARGE, WITH HYDRAULIC GRABS FOR DREDGING.
Built at the Elswick Works.

An illustration is given also on page 198 of a hydraulic capstan of 11-tons hauling power for dock use; the hydraulic engine and gear are arranged in a chamber below quay level. Vessels are now so large and heavy that powerful capstans such as these are required to work them in and out of dock.

In conclusion I have to acknowledge indebtedness to those firms who have so kindly supplied me with photographs and descriptions of their apparatus, and also to the authorities quoted in connection with the historical portions of this article.

COST KEEPING AND SHOP STATISTICS FOR A REPAIR SHOP.

By Albert W. Thompson.

The shop described by Mr. Thompson represents a very large class—that having no fixed line of manufacture or output—and one to which it seems especially hard to adapt an exact cost-keeping system. His article is thus invested with an unusual interest, which is well maintained in the manner of treatment.—THE EDITORS.

IN view of the extent to which cost keeping is practised in up-to-date shops at the present day, one might expect to find much similarity in the methods employed; but an examination of the systems used in many of the leading shops, descriptions of which have from time to time appeared in THE ENGINEERING MAGAZINE, will cause the reader to note that contrasts rather than similarities seem to be the rule. These differences in method, however, do not indicate differences in merit, for they arise from differences in the requirements imposed by circumstance; and the best system which can be devised for any particular shop is that which is best adapted to its individual requirements.

It is quite evident, then, that standard methods of cost keeping cannot readily be developed, even for manufacturing shops whose product has a certain amount of homogeneity; and it follows from this that in repair shops, which in one sense of the word have no product, we must resort to methods having little in common with those employed in manufacturing shops.

In devising such a system our real object is to reduce cost. We must take care, then, not to overburden ourselves with red tape and clerical expense, thereby defeating our own object, and we must distinguish carefully between the necessary and the superfluous. I believe that in a repair shop certain principles may be applied with good results, which might however be very poor policy in a manufacturing shop. For example, in fixing rates, approximation should be practised, instead of absolute accuracy. That is, we should pay special attention to means and averages, rather than to a mass of detail which confuses the mind and affords no real basis for comparison of results.

If our departments are relatively small we may safely depend on foremen for some clerical work. By using judgment we may thus

decrease our clerical expense, at the same time keeping before the eyes of the foremen certain facts and figures which tend to enable them to see the results of their work from a new and beneficial view-point. We must, however, not go beyond the point where the foreman's time is occupied to an extent detrimental to the efficiency of his departmental supervision.

Our foremen must not only supervise but improvise; that is, they must not only carry on their work, but to a large extent must plan the details. To illustrate: A routing and estimating department, invaluable in large shops, would hardly be applicable in a repair shop, where we should still have to have our foremen as supervisors, on account of the variable nature of the work. We could possibly do the work with cheaper foremen, but when good men can be found, perfectly capable both of planning the details of the work and of supervising it, it is, in my opinion, an efficient and inexpensive policy to use them in both capacities; and having such men, we may readily make use of a premium or bonus system of payments without the aid of a routing and estimating department.

We must not try to apply, in all departments, any particular rule or system. For instance, if we try to apply the premium system of payments in all departments, because we meet with good results in several, we shall in all probability cause much dissension and endless bother in many cases. It is perfectly practicable to use the day rate, straight piece work, and the premium plan, not only in the same shop but in the same department, and the use of all three systems may lead to much more efficient organization than if one of the three were strictly adhered to.

The machine shop of the Amoskeag Manufacturing Company, in Manchester, N. H., will serve as an example of a shop in which the principal business is repairs, in which the work presents a great variety of detail, and in which the above principles have been applied. I propose, after describing the shop and its requirements, to describe the methods of keeping costs and obtaining statistics which are here used, as well as a method of using the premium system of rewarding labor in conjunction with the ordinary day-rate system.

This shop makes practically all repairs for the Amoskeag Manufacturing Company, a large corporation manufacturing fancy cotton cloths; the Manchester Mills, a neighboring corporation manufacturing both cotton and woolen goods; and the Manchester Print Works, producing printed cotton cloths. Most of the other mills and small industries in Manchester maintain repair shops, but much of their

TABLE I. POWER AND MACHINERY IN THE AMOSKEAG SHOP.

	Amoskeag Mfg. Co.	Manchester Mills.	Manchester Print Works.
Annual production, finished cloth.....	138,000,000 yds.	10,000,000 yds.	54,000,000 yds.
Number of employees.....	7,800 hands	2,500 hands	700 hands
Productive machinery	12,000 looms	3,500 looms	17 printing machines
	320,000 spindles	76,000 spindles	
Horse power utilized continuously.....	14,000 horse power	3,400 horse power	1,000 horse power
" " available, steam	14,000 " "	1,500 " "	800 " "
" " " water	12,000 " "	2,200 " "	600 " "
Derived from outside sources, electric..	———	600 " "	300 " "

heavy repairs on engines, water wheels, etc., is done in the Amoskeag shop. In order to present to the reader a more definite idea of the amount of machinery kept in repair by this shop the adjoining table is appended, showing the spindles and looms represented, which, of course, represent a correspondingly large number of fly-frames, cards, pickers, dyeing and finishing machinery, etc., as well as shafting, pulleys and belting, engines, and water wheels. See Table I.

The principal function of this shop is to keep in repair the machinery and power plants of the mills above described, but "repairs" as used in this case is an elastic word and covers a large class of work better defined as alterations, the necessity for which arises from changes and improvements constantly being made in textile machinery, either in response to a demand for some new class of goods, or to facilitate the adoption and introduction of some improved mechanical device. In the following pages, then, repairs refer to work necessitated by wear and breakage. The volume of repair work is practically constant, but the demand for alterations is extremely variable, and when it does exist is urgent. To meet the ever-expected demand for alterations a considerable force is kept employed in the construction of new machinery, which, as the shop is well equipped, can be made at moderate cost. This work can be dropped to meet a sudden demand for alterations and taken up when opportunity offers, and thus a body of trained men is always in reserve, available for any sudden requirements.

A demand also constantly exists for certain small parts of machines which are subjected to more wear and breakage than others, but which are so simple as to be readily replaced by the "section hands" in the mills.

TABLE II. DEPARTMENTS AND ORGANIZATION OF THE SHOP.

	Hands.	*Equipment.*	*Work.*
Machine Shop Proper.	A 30	Bolt and screw machinery, automatic screw machines, milling machines, small lathes, drill presses, grinding and polishing machinery.	Bolts, screws, nuts, studs, pins, springs, hooks and lightest class of machinery parts made and repaired. Grinding and polishing.
	B 60	Light machine tools, chucking machines and automatic gear-cutters, special machinery for making fluted steel rolls.	Manufacturing and repairing looms, spinning frames, roving frames, and other textile machinery of the lighter classes.
	C 30	Medium sized machine tools for general work.	Building and repairing drying, dyeing, and finishing machinery and other textile machinery of the heavier classes. Repairing valves, etc.
	D 25	Planers and heavy machine tools.	Machining and fitting up shafting, hangers, couplings, pulleys, gears, etc. Engine and water-wheel repairs, etc. Heavy machine-tool work.
	E 20	Hand forges, steam and power hammers, special drop forging machinery for bolt work.	Forging of all kinds.
	F 30	Wood-working machinery.	Pattern work. Wood work of all kinds.
	G 12	Sheet-metal-working machinery.	Sheet-metal work and plumbing.
Small Departments in or near Main Shop.	H 10	Belt-making and leather-working machinery.	Belting and strapping made and repaired.
	I 16	Top-roll-covering machinery.	Top rolls re-covered for spinning and carding machinery.
	J 16	Pipe-threading and cutting machines.	Pipe fitting of all kinds.
Gangs having headquarters in and near Shop.	K 25	Painters' apparatus.	Machinery and mill painting.
	L 35	Millwrights' apparatus.	Heavy mill carpentry, hanging shafting, repairing floors, erecting and moving machinery, elevator repairs, etc.
	M 10	Masons' apparatus.	Light masonry, incidental to mill work, machinery foundations, whitewashing, etc.
Boiler Shop.	N 40	Power-shears and punches, plate planer, pneumatic riveting, chipping and drilling tools.	Boilers, steam pipes, tanks, etc., built and repaired. Heavy sheet metal work of all kinds.
Foundry.	O 60	Moulding machines, power cranes and hoists, pneumatic riddlers, chipping hammers, etc.	Iron and brass castings.

Such parts are kept on hand in the company's store house, and are ordered of the machine shop in quantity. This class of work is known in the shop and described hereinafter as "store-house work." The distribution of the labor required for these and other classes of work done for the mills will be shown later.

The organization of the machine shop as subdivided into departments will be best understood by referring to Table II., which also indicates the number and size of other departments comprehended in the same management. These departments are all operated by and for the Amoskeag Manufacturing Company. The foundry has its separate account on the company's books, being credited with the value of its output and charged with its expenses, and can show a definite profit or loss at the end of the year. The machine shop, however, cannot be thus treated, since to its principal output—repairs—no definite value can be assigned. All shop expenses, therefore, are charged to the repair account, which is credited with all amounts received in payment for shop work from the Manchester Mills and others, the balance at the end of the year representing the cost of repairs.

The functions of our system are these:—

1.—To determine with reasonable accuracy the cost of all materials and labor expended in work for outside parties, in order that prices may be fixed which will insure a reasonable profit on all such work.

2.—To determine the distribution of and account for the repair expense of the different departments of the mills of the Amoskeag Manufacturing Company and the Manchester Mills.

In the foundry a great variety of castings is produced, ranging from heavy gear and pulley castings weighing several tons down through all intermediate grades to the lightest possible class of machinery castings made in "strings" on the benches. Hand work prevails, though moulding machines are used wherever the number of pieces required warrants the initial expense of fitting up the patterns. Under these conditions the mean cost of labor per pound is far from being a good index of efficiency or basis for prices, for a change in the average weight causes a change in the mean cost per pound, and both vary considerably from month to month. The work is therefore divided into several classes, whose names (which are self-explanatory) appear in the column headings of the form shown in Figure 1. Payments are made every two weeks, and at the end of each payment each workman's labor and its cost is entered in the column or columns corresponding to the work on which he was engaged. This division of

AMOSKEAG MANUFACTURING COMPANY'S FOUNDRY.

Cost of Labor on Castings ..... *Payment Ending* ..... 19 .....

CLASS	RATE		HEAVY FLOOR		LIGHT FLOOR		MACHINE FLOOR		BENCHES		SNAPS		SMALL MACHINES		GENERAL		TOTAL	
NAMES	Task	Day	Time	Cost	Time	Cost	Time	Cost	Time	Cost	Time	Cost	Time	Cost	Time	Cost	Time	Cost

DATE. Jan. 5, 1904

NO. 1

CUPOLA.

	LBS. COKE.	LBS. COAL.	R. Kennedy	Bullard	Bushong						LBS. SCRAP.	LBS. SPRUES.	LBS. AT EACH CHARGE, AND TOTAL.	REMARKS.
CHARGE	750	800		1200	400						800	800	4000	
ADDED	350	600		700	200						700	800	3000	
DO.	300	400		400	200						700	800	2500	
DO.	300	400		400	300						800	860	2760	
DO.														
DO.														
DO.														
LBS. OF EACH,	1900	2200		2700	1100						3000	3260	12260	

BLAST PUT ON,	3.20	1 Lb. Fuel Melted 6.45 Lbs. Iron									
IRON FLOWED,	3.36										
BLAST TO IRON,	M. 16	PRESSURE OF BLAST IN OUNCES.									
		TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME
DROPPED BOTTOM,	4.35										
Blast to Drop of Bottom,	H. M. 1-15	OZ.	OZ.	OZ.	OZ.	OZ.	OZ.	OZ.	OZ.	OZ.	OZ.
				Full Blast.							

CONDITION OF METAL.	POOR.	MED.	SHARP.	V. SHARP.
			X	

CASTINGS.	SPRUES, &c.	TOTAL.	Short of Charge.	Defective Castings.
LBS. 8116	3480	11596	664	180
PER CENT. 70.00	30.00	94.60	5.40	2.20

AMOSKEAG MANUFACTURING COMPANY,

MANCHESTER, N. H.

(Supt's Stamp)

Recorded by W.F.

FIG. 2. DAILY RECORD OF RESULTS OF EACH MELT.

The original is 8 inches high and 12 inches wide. This form is adopted, with slight changes, from one used by a well-known New England firm, by whose kind permission it is used here.

Amoskeag Manufacturing Company

MACHINE SHOP

REPORT TO Richardson FOREMAN.

Payment Ending Jan 16 1904

Cost of Productive Labor	$1093.47
Cost of General Labor	48.00
Pay Roll	1141.47
Tools and Repairs	107.63
Supplies	36.99
Sundries	
Total Expense of Department	1183.99
Productive Labor Reported, hours	624
General Labor Reported, hours	120
Labor Unaccounted For, hours	
Total Labor, from Pay Roll, hours	6384
Labor, Average cost per hour	17 5/8
Net cost per hour of Productive Labor	17.7
Productive Labor to Total Labor, per cent	97.1

Reported by J. C. R.

Approved (Supt's Stamp)

FIG. 3. FORM FOR ENTRY OF COST OF PRODUCTIVE LABOR.
The original is 8½ inches wide and 7¼ inches high.

returned to the office of the shop superintendent, where a report to the management is made out showing the results of the month's work, summarized. The last monthly period in each six months contains six weeks instead of four, the object of this arrangement being to make the monthly periods begin and end with the two-week payments used by the company.

The foundry usually employs about 60 hands. One clerk only is employed, who acts as time keeper, weighs off and records all castings, makes out reports, and makes up all accounts for outside work.

In the machine shop, to secure absolutely accurate costs we should have to take into account the individual wage rate of each employee. To escape the immense amount of clerical work which would thus be necessitated it has been found advisable to determine the net cost of an hour's labor in each department by the following method:—

In each department all labor not chargeable to any particular job is classed as general (or non-productive) labor, including usually the foreman's and part of his second hand's time; also all labor employed

in cleaning shop, distributing castings, etc. Subtracting the number of hours of general labor from the total number of hours actually shown on the pay roll, we have the number of hours of productive labor for this department. Adding to the total cost of labor shown on the pay roll the cost of all small tools, supplies, minor repairs, etc., chargeable to the department within a given period of time, we have the total expense; this, divided by the number of hours of productive labor, gives the net cost per hour of productive labor. To this figure must be added the general expense for the entire shop and the usual fixed charges, all reduced to expense per hour of productive labor.

The cost of productive labor for each department is determined at the end of every payment, and entered on the forms shown in Figure 3. After being inspected and approved by the superintendent these are distributed to the foremen. Each foreman is thus provided with an index of his success in maintaining a low labor cost by keeping down his general expense, and this practice does much toward the prevention of careless ordering and use of supplies and encourages the maintenance of efficient departmental organization. In support of this method of determining the cost of labor it should be said that experiments, carefully made, show that whether the cost of a given

MACHINE SHOP.

Date January 2. 1904

NO.	ROOM	WORK ON	STOCK	TIME	PRICE
4	Weave	Stop motions Repair		4	
11	Cloth	Sewing Machine "		6¼	
"	"	" " Spring Steel	1 lb		

Name Wm. White

FIG. 4. DEPARTMENTAL TIME CARD.
The original is a card 5½ inches wide and 4½ inches high.

job is figured on the mean basis or on the individual basis the results are so close that the differences are negligible in practice. Moreover the cost per hour of labor in the different departments varies so slightly from the mean for the entire shop that it has been found desirable to adopt one price for all departments.

Excepting in one or two small departments where only one line of work is conducted, time cards (Figure 4) are used. Time cards are kept by individual workmen and checked daily by the foremen, but the clerical work involved is not formidable, since so many hands, in many cases in gangs, are employed for several consecutive days on one job.

Names	Class	S	M	T	W	T	F	S	S	M	T	W	T	F	S	Gen.	Stock	Reg.	
J. W. Brown	G		10 20	4	10 20	10 20	10 20	8 20		10 20	10 20	6	10 20	10 20	8 20	10 20			
	S																		
	R			6 20								2 20						8	40
Robert Jones	G													1		1			
	S				4						5	7 20					16 20		
	R		10 20	10 20	6 20	10 20	10 20	8 20		10 20	5 20	3	10 20	9 20	8 20			102	40
Wm. White	G																		
	S		10 20				3						10 20	8 20			32		
	R			10 20	10 20	8 20	7 20	8 20		10 20	10 20	10 20		2	8 20			86	
N. B. Prescott	G																		
	S																		
	R		10 20	10 20	10 20	10 20	10 20	7 20		10 20	10 20	10 20	10 20	10 20	8 20			120	
	G																		
	R																		
TOTALS																10 20	11 8 20	317	20

Reported by _____ Foreman _____

Payment Ending _____ 190

FIG. 5. FOR CHECKING TIME CARDS AND SEPARATING GENERAL FROM PRODUCTIVE LABOR. The original is 8½ inches wide and 14 inches high. The reproduction shows only the heading, footing, and plan of ruling.

To check the time shown by the cards and to separate general labor from productive, the form shown in Figure 5 is used. The figures shown in this form are taken from the time cards by a clerk, and failure to check with the time-keeper's records results in investigation. All labor unaccounted for is charged to the general expense of the department, thus showing unfavorably to the foreman, with the natural result that such discrepancies seldom occur. The time cards are sent to the shop office and sorted by the clerks, the entries being transferred to "charge slips" (Figure 6), one charge slip often representing a large number of time cards. Each charge slip indicates the department or account to which the items upon it are chargeable, and is

Charge to # 11 Cloth Room

Stock and Labor on _____ Order No. _____

Repair Folder Rod

Date	Remarks	Stock	Time	Price	Cost
	Labor		1		
	Refined Iron	2			
	TOTALS				

* Returned 1-8 1904 E. H. C. Foreman

FIG. 6. CHARGE SLIP.
The original is 5¼ inches wide and 4 inches high.

Charge to # 11 Cloth Room Truck Repairs

ARTICLES SUPPLIED FROM STORE HOUSE.
During Payment Ending 1-2 1904

DATE		ARTICLES	PRICE	AMOUNT	
		Screws, 1¾" #12 - ½ Gross			14
		TOTALS			

Signed G. H. S.

FIG. 7. STORE-HOUSE SUPPLY FORM.
The original is 5¼ inches wide and 4 inches high.

filed behind the proper index card in a card catalogue kept for this purpose. Stock charges are returned by foremen on charge slips showing the amount of stock used, in all cases where considerable amounts of bar stock are used from shop storage. When the amount used is small it may be entered on the time card of the workman to whom it was supplied. Castings used are charged by the clerks, the amount being copied from returned foundry orders and entered on charge slips. Foremen, both for stock and labor, return amounts only, all prices being affixed and values computed by the office clerks from lists kept for the purpose. Special stock and sundry supplies not kept on hand in the shop are ordered of or through the store house, and

Amoskeag Manufacturing Company

MACHINE SHOP ACCOUNT

Mill No. 10 Jan 6th 1904

Weave Room.

Repair crank-shaft

Signed: Lyttlebody Overseer.

Approved: A. W. F. (R) Foreman.

Filled Jan 7 1904 W. R. S.

No.

N.B. Orders must be signed by Overseer and approved by Supt. of Shop. No new work will be done without approval of Supt. of Manufacturing.

FIG. 8A. FOR MILL OVERSEERS' REPAIR ORDERS AT MACHINE SHOP.
The original is 8 inches wide and 5¼ inches high.

from this department returns are made of all articles supplied, and their cost, on a special form (Figure 7) which is of the same size as the charge slips and is filed with them. Most of the bolts, nuts, screws, studs, and certain small parts used in large quantities are made in special machinery in the bolt and screw department, all stock and labor used for such purposes being charged and accounted for as "stock." The cost of such articles being easily determined and very uniform, they are kept on hand in bulk and when supplied are charged from fixed price lists, the number and price being entered on the face of the order upon which they are delivered. All such orders are returned to the office and the entries transferred to charge slips. Figure 8 shows

Shop Department Order.

Mr. Blanchard Jan 11 1904

350 Set - Screws, 5/16" x 3/4"

Ordered by Stickney.

For Loom Hdls #3 Manchester Mills

Out 1-11-04 190 A.C.B. Foreman.

FIG. 8B. SHOP FOREMEN'S INTERCHANGE REPAIR ORDER.
The original is 5 inches wide and 2¾ inches high.

the order forms used (A) by the mill overseers in ordering repairs at the machine shop; (B) by the shop foremen in ordering work of each other; (C) by the shop foremen in ordering castings from the foundry. Form C provides a duplicate carbon copy, kept by the foremen for reference. Form C with duplicate and triplicate copies is used in the shop office, and when castings are ordered the original order goes to the foundry and the duplicate to the shop foreman who is to finish the work, and is equivalent to an order to finish it and a notification that the castings are ordered. Foundry orders, when the castings are all made, are returned to the foreman who finishes the castings with their number and weight entered on the face of the order. After the work is finished the orders are returned to the shop office and the weights transferred to the charge slips.

No. 8246 AMOSKEAG MFG. CO. Jan 6 1904

Mr. Fairfield

48 Gears 70 Teeth to Sample

50 - 10 Lbs

For 7 Spinning Man Mills

Signed Stickney Foreman.

Out Jan 13 1904

FIG. 8C. SHOP FOREMEN'S REPAIR ORDER FOR FOUNDRY WORK.
The original is 6 inches wide and 2¾ inches high.

AMOSKEAG MANUFACTURING COMPANY.

MACHINE SHOP

Manufacturing Account, *Payment Ending* *19*

DEPARTMENT	MACHINERY. Repairs	MACHINERY. Alterations	SHAFTING. Repairs	SHAFTING. Alterations	BELTING AND STRAPPING.	FURNITURE AND APPARATUS.	WINDOWS AND FLOORS.		
1 Carding									
3 "									
4 "									
9 "									
10 "									
B M "									
1 Spinning									
3 "									
4 R "									
4 M "									
9 "									
10 "									
B M "									
1 Dressing									
3 "									
4 "									
7 "									
9 "									
10 "									
11 "									
3 U Weaving									
3 L "									
9 U "									
9 L "									
8 "									
N C "									
C S "									
10 "									
11 U "									
11 M "									
11 L "									
11 S "									
B M "									
Blue Dye House									
Col. " "									
Warp " "									
Harness Room									
Design "									
10 Napper									
10 Cloth Room									
11 Napper									
11 Cloth Room									
11 Size "									
Heavy Dep't									

FIG. 9. MANUFACTURING REPORT.

The original is 8½ inches wide and 14 inches high, ruled in red.

Amoskeag Manufacturing Co.

MACHINE SHOP

DISTRIBUTION OF LABOR

Payment Ending January 16th 1904

FOREMEN.	Manchester Mills	Storehouse	New M'ch'y.	Alterations	Repairs		Tenements	Balance	Totals
B	505	155	149	167	2053		1	150	3180
A	2079	726	567	22	1922		4	29	5349
C	1516	17	679	341	675			16	3244
F	574	100	370	105	1650			9	2808
E	601	43	81	45	720		4	16	1510
D	1551	2	64	1170	917		54	13	3771
G	884	2	6	20	296		132	2	1342
I	2777		88	48	535			19	3467
Totals	10487	1045	2004	1918	8768		195	254	24671
Per cent	42.5	4.2	8.1	7.8	35.5		8	1.1	

Approved ___ (Supt's Stamp.)

FIG. 10. CLASSIFICATION OF LABOR FOR DISTRIBUTION OF LABOR REPORT.
The original is 8 inches wide and 9 inches high.

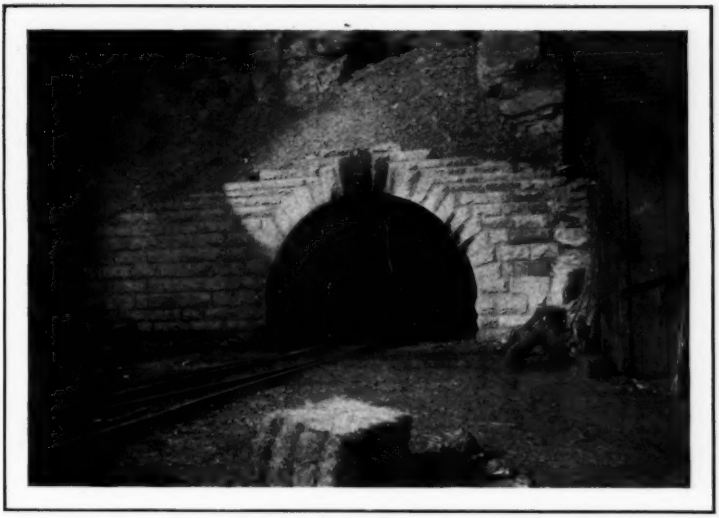
At the end of each payment, after all charges are transferred, the manufacturing reports are made out. Figure 9 shows the form used for the Amoskeag Company, which is similar to those for the Manchester Mills and Print Works. The amounts shown on these reports are the totals shown by the charge slips, as an itemized account would be undesirably voluminous. The charge slips, however, are preserved for several weeks for reference in case of questions arising as to details. The reports are sent to the manufacturing superintendents of each mill. Reports of the cost of repairs pertaining to the power plant

and other reports of a special nature are compiled in the same way and returned to the general superintendent and certain other officials.

To prepare the "Distribution of Labor" report the charge slips are re-sorted, and the labor shown by them for all the large departments is divided according to the classification indicated on the form shown in Figure 10. When completed this report shows the work of each class done, in hours of labor, in each department, and the relative amount of labor required for each class expressed as a percentage of the whole. The utility of this report is not perhaps apparent to the casual observer; but coupled with a knowledge of the demand for work of each class, and the state of completion, it is of great use to the management in planning the distribution of work and help. For example: if an important alteration job is about to be undertaken, we can judge very well from what class of work all or part of the necessary help can be taken, and from what departments they can best be spared without interfering too seriously with some other class of work which, for the time being, may be equally important.

It will be noted that the Manchester Mills labor is shown in a class by itself on this report; but it appears, divided according to the same classification, on a second report which is sent to the Manchester Mills management.

Such, in brief, is the cost-keeping and shop-statistics system of the Amoskeag mills. A following article in the next issue of this Magazine will explain the method of adapting the premium plan of wage payment to the conditions of the work, and the forms and blanks used in its administration.



A MINE ENTRANCE, POCAHONTAS, VIRGINIA.

COALS AND COAL-MINING METHODS OF THE POCAHONTAS FIELD.

By Geo. L. Fowler.

Mr. Fowler's interesting account of the geological and mining features of the Pocahontas region will be followed by a second taking up the economic aspects of the field.—THE EDITORS.

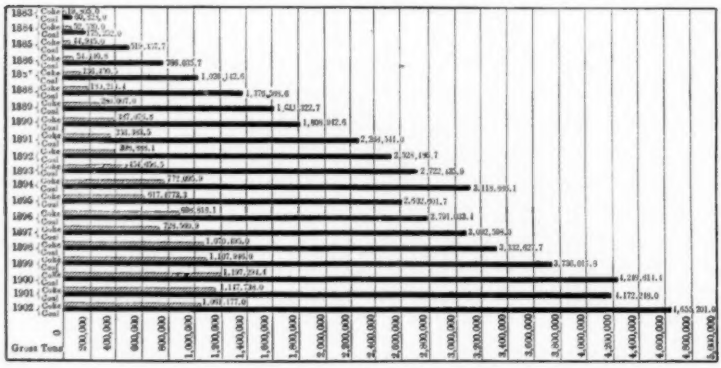
THE saying that a truly good thing will surely be appreciated, coupled with the one of perhaps doubtful truth, that "all things come to him who waits," has been fully sustained by the history of the success that has attended the exploitation and development of what is known as the Pocahontas coal.

The field is situated on the border line between Virginia and West Virginia, slightly overlapping into and extending over parts of Tazewell and Buchanan counties in the former State, but located for the most part in the counties of McDowell, Wyoming, and Mercer in the latter. It includes about 450 square miles of rough mountain land, unsurpassed for scenic beauty and consisting of a succession of ridges rising from 200 to 800 feet above the streams, which themselves flow at an elevation of about 2,000 feet above the sea.

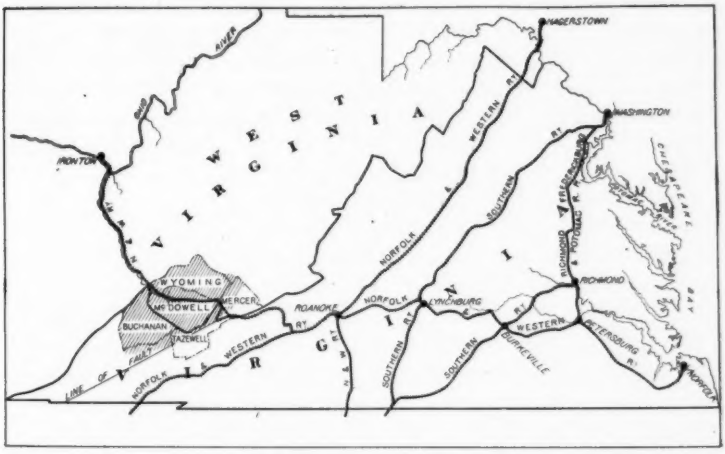
It was in 1882 that the first mine in the vein now known by the name was opened at the village of Pocahontas, in Tazewell Co., Virginia. The locality has thus given its name to the region and its product. In the first year the output amounted to but 60,828 gross tons, and though in the second year two new operations were opened, and the total output was increased to 175,252 gross tons, the introduction of the new coal to the markets of the eastern States was both slow and discouraging, so that for a time the operators were sorely tempted to abandon the venture. There was no possibility of reaching the western market, as the Norfolk and Western Railway had been built into the mountains from the east only, and so little was known of the field, and it was thought to be so limited in extent, that capitalists in some cases refused to so much as to investigate the coal lands. The completion of the railroad through to the west was a mere scheme, laid out over a route down Piney Creek which was afterwards abandoned, the construction being carried down the valleys of the Elkhorn Creek and the Tug River.

So with comparatively poor means of transportation, with limited capital, and with but little experience, it was a difficult piece of work to introduce this new grade of coal into a market already devoted to the use of Pennsylvania anthracite and bituminous coal. The article was, however, of such a character that after its merits had once been appreciated, the demand increased by leaps and bounds, and the first mine (whose output was 60,828 tons in 1882) touched its high-water mark at 705,333 tons in 1888.

The reason for the later falling off in the output of this particular



GRAPHICAL ILLUSTRATION OF COAL AND COKE SHIPMENTS FROM THE POCAHONTAS FIELD.

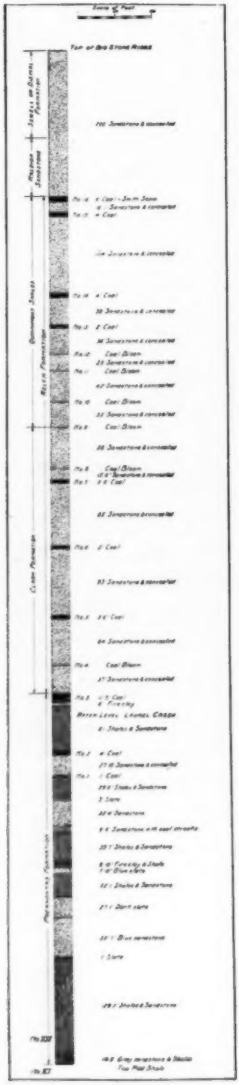


MAP OF VIRGINIA AND WEST VIRGINIA, SHOWING THE LOCATION OF THE POCAHONTAS COALFIELD AND THE RAILWAYS AFFORDING TRANSPORTATION FACILITIES.

mine is two-fold. The principal difficulty of holding it at this high figure is due to the rapid development of other operations in the field, which grew more rapidly than the facilities of the railway company, and as each operation is entitled to a fixed percentage of the equipment, the shortage of rolling stock had the effect of curtailing the output. The other, though minor cause, is the fact of the increased haulage required in the mines in later years, whereas in the early days the mining was done nearer the outcrop at the surface. It is, therefore, probable that if the railway facilities had increased in proportion to the operations, the one mentioned would not have reached its high-water mark in 1888.

As more extensive surveys were made and the true area of the field was ascertained, capital was more than eager to invest in the lands, until now nearly the whole is under the control of large and wealthy corporations. In order to convey an idea of the growth of the industry the accompanying graphical chart has been prepared.

With this brief review of the growth of the industry, let us now turn to the reason therefor. It may be truly said to be due entirely to the quality of the goods offered to the consumer. Handicapped as it was by its location and the excessive transportation charges which it had to meet—charges that obtained whether it were offered in the eastern or western markets—its use depended upon its superiority, and on this alone it has won its present position.



TYPICAL GEOLOGICAL SECTION, POCAHONTAS COALFIELD

The main vein is known as the Pocahontas No. 3. It will be seen by a reference to the typical geological section of the field that the coal measure upon which the wealth of the region is based is among the lower of the coal formations of the district, and is about 870 feet below the top of the Big Stone Ridge; it lies immediately over a bed of fire-clay, resting upon a stratum of shale, and buried beneath hundreds of feet of sandstone that is always closely associated with the coal measures, and about 2,000 feet above the limestone, a fault in which brings the field to an abrupt termination on the south-eastern border. This fault undoubtedly lifted the carboniferous strata with the superincumbent sandstones, all of which have been eroded by the countless æons that have passed since they were displaced. Traces of the coal measures, however, are still found in isolated places to the eastward, showing that in all probability they once extended to the ancient seashore on the eastern slope of the Blue-ridge Mountains. It is probable, too, that these eastern beds were thicker than those now being worked, as the veins exhibit a constant tendency to thicken in that direction. To quote from the recent report of the West Virginia Geological Survey:

> "The entire thickness of the rocks in the Carboniferous system varies much in different portions of the State. In a general way the several series composing the system thicken eastward, gradually in the northern portion, but very rapidly in the southeastern region. This gives a rapid thickening southwestward along the western flanks of the Alleghany mountain range."

It will be seen from the vertical section that the major portion of the upper measures are very thin and not workable. Most of these have been eroded from the territory

of the Pocahontas field and appear to the west under other names, and thus fall outside the province of this article. It may be merely mentioned in passing that the most important of these to West Virginia is the Thacker vein, shown as No. 5 on the section. The thickness of this is given as 3 feet 6 inches, which sinks to comparative insignificance beside the 11 feet 3 inches of the great Pocahontas vein No. 3. In referring to this section it must not be understood that it actually exists as shown in the engraving on the Pocahontas field. This is a typical geological section. As a matter of fact, in the field itself there is not cover enough overlying the No. 3 vein to hold the higher measures, but in moving down the Elkhorn in the direction of the

AN OUTCROP OF COAL AT POCAHONTAS.

Tug River the Pocahontas vein finally drops down below water level, and then as it passes beneath the mountains on the west, they admit of the overlying coals coming in; these, in turn, as they go to the northwest gradually go down to the water level and also disappear. Between the Pocahontas coal measures and the Thacker measures there is a large area made up of heavy sandstone, which is known as the "Run of the Tug" and indicates a barren period between the two. This barren period comes in on top of the Pocahontas coal. The Thacker vein is younger, contains more volatile matter and bitumen, and consequently gives off a heavy smoke.

The peculiarity of the Pocahontas coal is to be found in its low

content of ash and volatile matter, as well as of sulphur and other impurities, and the resultant high percentage of fixed carbon with the high calorific value that follows upon such conditions. The Pocahontas vein is thought to correspond to the anthracite vein of red-ash coal of the Lykens Valley near Pottsville, Pa. The geological explanation of the difference is that the anthracite bed was subjected to a more thorough coking process under pressure than the Pocahontas portion of the vein, while the latter owes its own lack of volatile matter to the fact that it was subjected to heat under pressure for a more protracted period than the bituminous coals of western Pennsylvania and Ohio. Just what this process actually was, geologists are as yet by no means positive, beyond the bare outline that has been given.

In order that the comparative value of this fuel with others may be understood the following analyses are given:—

PROXIMATE ANALYSES AND HEATING VALUES OF SOME AMERICAN COALS.

Coal.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur.	Heating Value per lb. B.T.U.	Relative Heating Value Based on Pocahontas 100.
ANTHRACITE:							
Southern Field, Pa..	3.09	4.28	83.81	8.18	.64	13,220	88.
SEMI-ANTHRACITE:							
Bernice Basin	.65	9.40	83.69	5.34	.91	13,700	91.
SEMI-BITUMINOUS:							
Clearfield Co., Pa...	.76	22.52	71.82	3.99	.91	14,950	99.
Cumberland, Md. ..	1.09	17.30	73.12	7.75	.74	14,400	96.
Pocahontas, Va. ...	1.00	21.00	74.39	3.03	.58	15,070	100.
BITUMINOUS:							
Connellsville, Pa. ...	1.26	30.12	59.61	8.23	.78	14,050	93.
Pittsburg, Pa.	1.37	35.90	52.21	8.02	1.80	13,410	89.
Thacker, W. Va....	1.38	35.04	56.03	6.27	1.28	14,040	93.
Hocking Valley, O..	6.59	34.97	48.85	8.00	1.59	12,130	81.
Scott Co., Tenn.....	1.26	35.76	53.14	8.02	1.80	13,700	91.
Jefferson Co., Ala...	1.55	34.44	59.77	2.62	1.42	13,770	91.
Big Muddy, Ill.....	7.50	30.70	53.80	8.00		12,420	82.
Mt. Oliver, Ill.....	11.00	35.65	37.10	13.00		10,490	69.
Missouri	6.44	37.57	47.94	8.05		12,230	81.
LIGNITE:							
Iowa	8.45	37.09	35.60	18.86		8,720	58.
Utah	9.29	41.97	44.37	3.20	1.18	11,030	73.

Setting aside the anthracite and semi-anthracites, the superiority of the Pocahontas semi-bituminous coal is clearly recognizable. Its

only rivals are the Clearfield and Cumberland coals, and these not only fall below it in the amount of fixed carbon, but rise above it in the quantity of ash, the Cumberland coal alone falling below it in the percentage of volatile matter. And in freedom from sulphur it outstrips all others. With these qualities it naturally follows that it stands highest in calorific value, though pressed within a small percentage by the rivals already mentioned.

MINE OPENING, SHOWING THE OUTCROP, ENNIS, WEST VIRGINIA.

It should be borne in mind that this refers to these coals in their palmy days, when the thicker vein of the Cumberland was being worked; for since this has been to an extent exhausted and the thin overlying one is being mined, Cumberland coal has lost much of its early standing. The same statement practically holds true of the Clearfield also. Another comparison with similar coal is given below taken from calorimeter and boiler tests and a theoretical calculation.

RELATIVE VALUE OF COALS.

Hocking = 100.

Coal.	Calorimeter Test.	Boiler Test.	Calculated Evaporation Value.
Hocking	100	100	100
Pocahontas	122	127	131
Thacker	116	117	116
Freeport	109	106	109
Darling	112	105	109
Pittsburg	113	113	114

OUTCROP ON A TRAMWAY LINE NEAR THE MAIN OPENING, NO. 7 MINE.

All of which merely goes to show that the Pocahontas is what it is claimed for it—one of the best steam coals, if not the best of the world.

It may be stated that the analysis of the Pocahontas coal as given in this table is the average of three analyses, made of the coal taken from three different points in each of the mines of the territory, by a disinterested party who was considering the advisability of using Pocahontas coke for metallurgical purposes. The result was that it was so adopted. In this connection it should be definitely understood that the analysis given is an average and represents neither the best nor the poorest samples. In some instances the sulphur rose to 1.42 per cent. and in others it dropped to 0.25 per cent., while the calorific value in one instance was 15,782 thermal units.

The vein, too, is not always of the same thickness, but varies, becoming thinner towards the edge of the territory, dropping down from a maximum of 11 feet at the center to 4 feet or less at the edges. Sometimes this occurs as the result of a split, where a wedge-shaped mass of shale is thrust into the body of the coal, deflecting the upper portion from the main section upward at the rate of about 20 feet to the mile.

This thinning of the vein has an apparent influence upon the content of volatile matter, in that the quantity decreases with the thick-

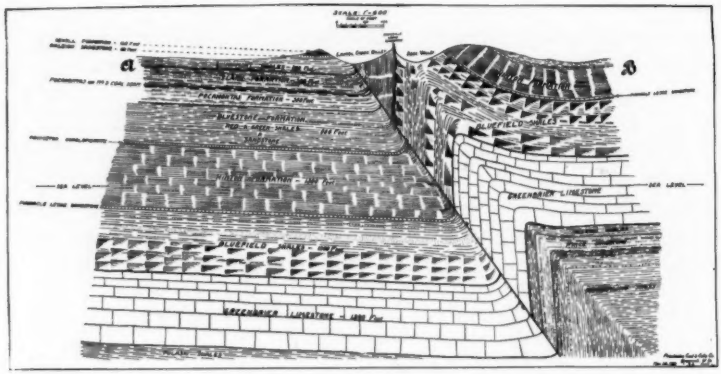
ness. This adds another argument in favor of the coking theory of its formation, in the probability that it was more difficult, with an equal application of heat for equal periods of time, to coke the thick masses than it was the thin, with the result that the former still retain the higher percentage of volatile matter.

Pure and of as high a grade as the coal is, the seam carries two thin streaks of impurities. They are from one to two inches in thickness and are known as the bone and sulphur bands. The former is merely a low grade of coal, high in ash and difficult to burn, but still quite possible to use in an ordinary furnace, though its calorific power is necessarily low. The sulphur vein is an entire misnomer. There is no sulphur in it whatever, but it is an exceedingly hard sandstone that will not melt in an ordinary fire, but when the latter is forced a clinker will sometimes form from a substance that has not yet been clearly determined. This does not occur regularly, but only occasionally, which indicates that the impurity is not present at all times in the vein, for, if it were, it would soon be detected and determined.

The area occupied by the seam under consideration is defined upon the map, but in reading this it must be understood that as the dip is to the north about 40 degrees west, the limits of the stratum in that direction have not been determined. On the southeast the seam comes to an abrupt termination on account of a fault in the rocks. This fault runs in practically a straight line northeast and southwest down the Clinch Valley division of the Norfolk and Western Railway, having the Clinch River as a dividing line, with limestone on the east and some of the coal measures on the west. It passes just to the east of Lookout Mountain in Tennessee, and is caused by the elevation of the limestone that lies beneath the sandstone underlying the coals, which is itself 1,100 feet thick, so that to the east of the fault the limestone is about 2,000 feet above its normal position, and in its rise it has carried the coal seams with it and along the edge has turned the main Pocahontas No. 3 seam so that it is vertical.

This same fault is observed at Cumberland Gap, with the limestone measures on the east and the Middlesboro coals on the west. Beyond Lookout mountain it runs down into the Birmingham field, and ends at a point that has not yet been located.

The distortion that was caused by this elevation is clearly shown by the geological cross section of the Abbs Valley fault. The actual break is quite as distinctly marked as that shown in the engraving, and the resistance to the upward movement of the strata lying to the east at the point of fault is shown by the turning of the same into that



GEOLOGICAL CROSS SECTION, SHOWING THE ABBS VALLEY FAULT.

vertical line already noted. Beyond the line of fault the coal and upper strata have been for the most part eroded, though traces of them can be found in places. The thickness of the seam varies from 6 to 11 feet, and the coal is so free from gas that safety lamps are not used in the mines and are only held for use in cases of emergency.

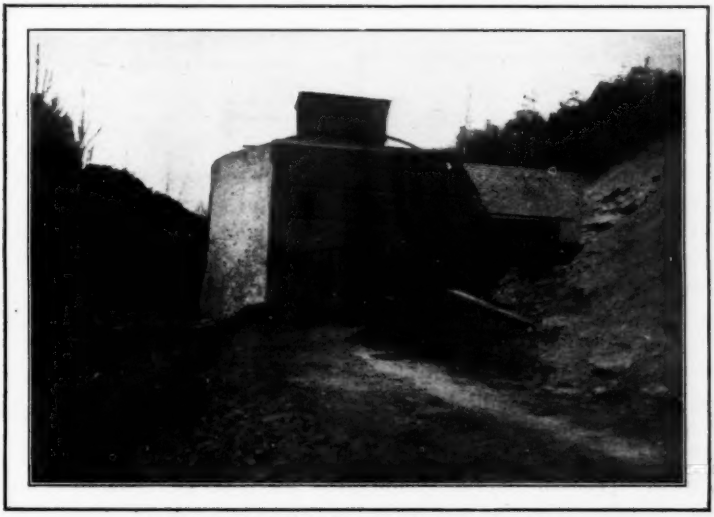
The common method of mining heretofore used is the double-entry system with rooms driven off opposite each other at right angles to the main entries or headings. The accompanying engraving shows a typical mine working that has been developed along these lines. In the first place the two parallel entries are started in from the outcrop. They are 10 feet wide with a pillar of coal 50 feet wide between them. As they advance artificial ventilation becomes necessary, and at intervals of 100 feet or so the break-throughs are cut. The laws of West Virginia now require that these shall not be more than 100 feet apart, though formerly they were spaced at much greater distances than this, being, in fact, cut only when the miners felt the need of fresh air. The ventilation is almost invariably accomplished by means of an exhaust fan placed over an opening in the outcrop, and in this typical plan, it is placed at the opening of one of the entries. If unimpeded, the natural flow of the air would be in at one entry, across to the other by way of the first break-through, and thence back to the fan. Such a state of affairs would leave both entries—and in fact the whole mine beyond the first break-through—without any ventilation. This condition is met by placing a stop or brattice in each successive break-through, leaving only the last one open to the draft. The result is that there is a powerful air current passing in at one entry, moving down

it to the last break-through, and thence back. Under these conditions the rooms that are cut out at right angles obtain their ventilation by diffusion. Sometimes the rooms or entries are carried through to the outcrop and this distant opening is made to serve as the intake for fresh air. In that case a door is placed across one of the entries, by which the influx of air is cut off except when opened for the passage of a car or train.

The course of the ventilation in a secondary mine is also shown, where there are the two main entries from one of which two or more are driven off at right angles to one of the former. This is then stopped between the two and the air current made to follow the long and devious course to the very depths of the mine as indicated by the arrows. Where the rooms of the two mines are run together their ventilating currents are separated by brattices.

The fans that are used for this ventilation are from 25 feet to 40 feet in diameter, with a capacity of 300,000 to 500,000 cubic feet of air per minute, and are driven either by an individual steam engine or an electric motor, dependent upon the location. If they are near the central power house and within easy reach of steam, engines are used; but if they are over a distant opening in the outcrop, as in the illustration, they are driven by electricity.

The rooms that are led out from the entries on either side are



VENTILATING-FAN HOUSE, POCAHONTAS, VIRGINIA.

spaced about 60 feet apart between centers. They are driven from 18 to 20 feet in width, with an entering neck 10 feet wide, thus leaving a supporting pillar between them from 40 feet to 42 feet thick. Here timbering is sometimes used in the form of props set from 6 feet to 8 feet apart on the gob or off side, leaving room for the track next

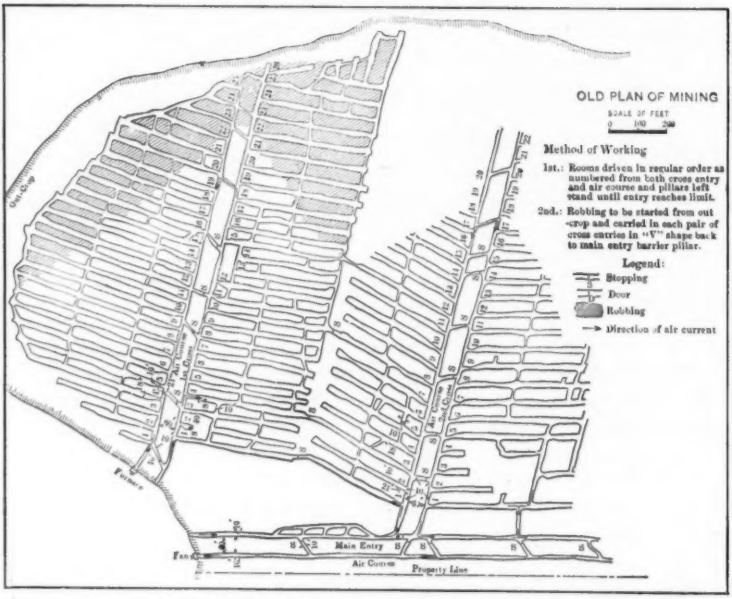

OLD PLAN OF MINING
SCALE OF FEET
0 100 200
Method of Working
1st.: Rooms driven in regular order as numbered from both cross entry and air course and pillars left stand until entry reaches limit.
2nd.: Robbing to be started from out crop and carried in each pair of cross entries in "V" shape back to main entry barrier pillar.
Legend:
Stopping
Door
Robbing
Direction of air current
Main Entry
Air Course
Property Line

DIAGRAM ILLUSTRATIVE OF OLD SYSTEM OF MINING.

the main wall. The main body of the room widens to 18 feet immediately back of this. The object is to retain as large a body of coal as possible along the entries to protect them from the effects of any squeezing due to the yielding of the coal beneath the superincumbent rocks. The character of the overlying strata is such that for the width of entries and rooms here used, no timbering is needed, except that just specified.

After the mine has been blocked out a systematic robbing of the pillars is begun, as indicated by the hatched section of the engraving. The work is begun at the farthermost corners of the mine and the pillars are cut away in a V formation, working back towards the main entries. Theoretically this should make it possible to obtain all of the coal, but as a matter of fact squeezing is apt to run ahead of a cave-in

of the roof, whereby a considerable section of coal is crushed and mingled with the débris from above and thus lost.

As the pillars are robbed the roof naturally falls in, but it is of such a character that it falls piecemeal and arches over, the loose pieces filling the whole space beneath, and in this way the upper surface of the ground is not often disturbed except by the loss of the water from a well or the disappearance of a stream, though, of course, surface subsidences do occur.

In order to avoid this waste of coal due to squeezing following upon the robbing of the pillars, a modification of the double-entry system has been introduced. A typical plan of a mine worked out along these new lines is shown in the engraving, and is known as the panel system.

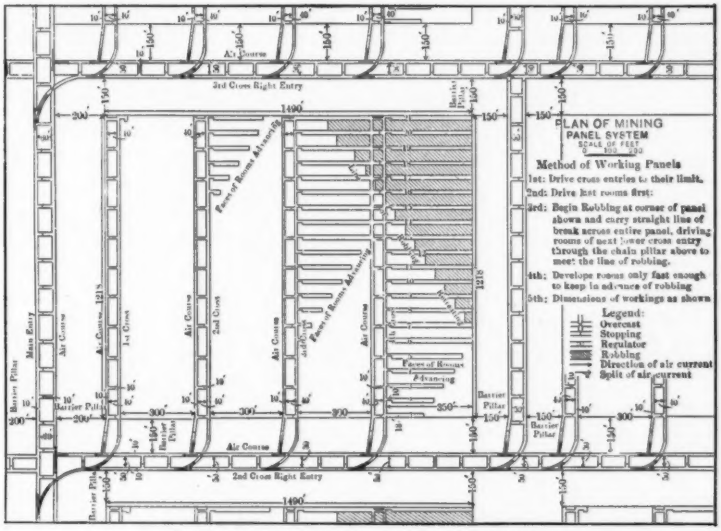

PLAN OF MINING
PANEL SYSTEM
Method of Working Panels
1st: Drive cross entries to their limit.
2nd: Drive last rooms first:
3rd: Begin Robbing at corner of panel shown and carry straight line of break across entire panel, driving rooms of next lower cross entry through the chain pillar above to meet the line of robbing.
4th: Develope rooms only fast enough to keep in advance of robbing
5th: Dimensions of workings as shown
Legend:
Overcast
Stopping
Regulator
Robbing
Direction of air current
Split of air current
Air Course
Barrier Pillar
Main Entry
1490'
1218'
350'
300'
200'
150'

DIAGRAM SHOWING NEW SYSTEM OF MINING.

There are the same entries with 50 feet of coal between them as before; but instead of leading the rooms directly off from these, they are flanked on either side by a barrier pillar 150 feet wide to carry the roof and maintain the integrity of the entries until the end, while the rooms are driven off from subsidiary or cross entries.

The method of working is to drive the cross entries to their limit, with the necessary break-throughs, thus forming what is known as a chain pillar. When this has been done the last room is driven first,

and pillar robbing is begun at once as indicated by the hatchings. In this way it will be seen that there is always a large body of coal coming up to the robbing line, and this will have sufficient strength to carry the roof and prevent that squeezing which is so wasteful of the coal. The ventilation of the new system is the same as that of the old and the course of the air currents is clearly indicated by the arrows on the plan.

As this coal is so free from gas that the safety lamp is not needed and that open lamps are used, and as the location of the vein is well upon the hillside, the mining operations are comparatively simple. In only a few instances are mining machines used. The under cutting is done by hand, the miner starting in with a height of about 18 inches and working back for about 6 feet, where he will have a height of 6 inches. A powder blast is then exploded overhead and the mass blown down. It is loaded into cars and the miner is paid by the carload. Tracks are run into the rooms from the main entries and the cars are hauled out by either electric or steam locomotives, though the latter are used in the majority of cases. In a few instances the electric motors are fitted with a cable by which they can maintain connection with the main wire while working in and out of the rooms.

The cars are simple four-wheeled lorries with a swinging end door permitting the whole car to be tilted and dumped at the tipple. This whole mechanism is of the simplest design but answers its purpose most admirably. The cars as they are hauled out from the mine are left on a siding, from which they can be dropped down by gravity one at a time to the upper floor of the tipple to be dumped. This done, they run by gravity back onto another siding where they are coupled in trains to be taken back to the mines. The coal dumped from the cars falls into pockets, from the bottom of which chutes carry it to the cars in which it is taken to market.

Inspection begins in the mines, where the miner is required to pick out all of the bone and sulphur band and gob the same in the rooms. Then, as the coal runs from the chutes into the cars, there is a second careful inspection and every piece to which any bone or sulphur (sandstone) is adhering is picked out and thrown aside, so that the coal leaves for the market in first-class condition. It is this inspection, which is exceedingly rigid, that accounts for much of the high reputation of the Pocahontas coal.

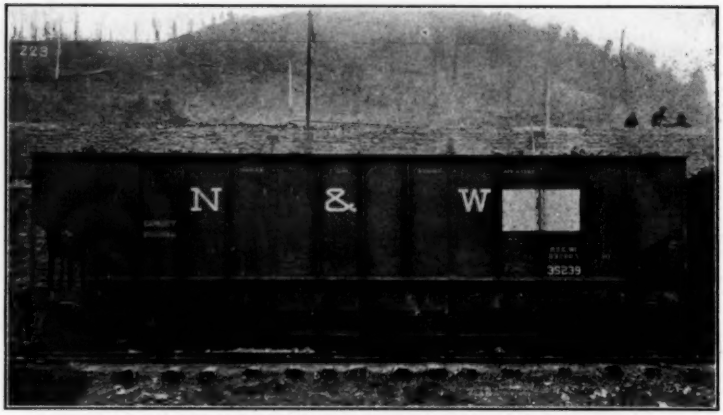
Efforts have been made at various times to design a machine to separate this bone and sulphur (sandstone) from the pure coal, and the indications are that one will soon be in active and successful opera-

A MINE TIPPLE, POCAHONTAS, VIRGINIA.

tion; then hand picking will come to an end. Meanwhile some operators are considering the advisability of introducing pickers at the chutes before the coal reaches the hoppers, in accordance with the current practice at the anthracite coal breakers.

There is comparatively little machinery in one of these tipples, and until a few months ago, with the one exception of that at the Gilliam colliery on the North Fork Branch, they were invariably built of wood. This Gilliam tipple is of steel and was built about eight years ago, and recently a second structure of the kind has been put into operation at Elkhorn, West Virginia, and another is in course of construction at Pocahontas. There is usually an elevator for raising fine material, but the principal elements consist of an upper dumping floor; screens upon which the coal falls direct from the mine cars, and by which it is screened and sorted according to size; hoppers in which the coal is temporarily stored previous to loading, and chutes by which it is loaded into the railway cars.

Turning now for a brief review of the extent of the industry we find that in the first year, 1882, the output from the single operation that had been opened was 60,828 tons. The next year two operations were added and their total output was 175,252 tons. From that time on the growth has been rapid, new operations coming in constantly



NORFOLK & WESTERN RAILWAY 100,000-POUND CAPACITY COKE CAR.

and old ones adding to their facilities, until at the end of 1902 there were forty-eight at work with an annual output of 4,655,210 tons.

All this coal is hauled to the eastern and western markets by the Norfolk & Western Railway, whose policy has been one of liberal encouragement. Spurs have been led off from the main line at innumerable points so that the high-capacity cars of the railroad can be run directly to the mines for loading. In this, too, the railroad has been in the van in the introduction of large locomotives and cars.

It was amongst the first to realize the economic value of cars of 80,000 and 100,000-pounds capacity. Within the past two years important works of improvement have been undertaken, in the elimination of curves in the mountain section of the line and the establishment of large receiving yards at points where the traffic originates. These yards have been planned with the utmost care and stand as models of this class of work. That at Bluefield, which is the receiving, weighing, and distributing point for a large section of the Pocahontas field, will have, on the completion of the present work of enlargement, a length of nearly five miles and a capacity of 3,500 cars.

Here the cars are received, sorted, and started east over a line where every grade has been studied to a nicety and such a system of pushing and helping engines introduced that each locomotive is working to its maximum efficiency over the whole distance of 364 miles to the sea. Norfolk, Va., is the tide-water terminal, and here are large docks with steel trestles and chutes from which the coal may be loaded into vessels at the rate of twenty carloads, or 1,000 tons, per hour.

BOILER DESIGN AND BOILER EXPLOSIONS.

By R. S. Hale.

Mr. Hale is engineer to the Mutual Boiler Insurance Company. His paper is therefore the fruit of specialized study, supported by the enormous fund of information supplied by special facilities. It is a systematic and comprehensive analysis, valuable alike to the maker or the user of steam boilers.—THE EDITORS.

IN designing a new boiler, or in determining the permissible safe pressure on an old boiler, it is customary to make detailed calculations as to the strength of the important parts. In these calculations the most important term is always either a "factor of safety," as in the case of boiler shells, where the "factor of safety" is usually taken as about 5, or a "safe working stress," as in the case of boiler braces, where the "safe working stress" is usually taken at about 8,000 pounds per square inch. It is obvious that these two modes of expression really represent the same thing. We take the strength of the metal of which the boiler is made as 60,000 pounds per square inch, so that "a factor of safety of 5" is the same thing as a "working stress of 12,000 pounds per square inch," or on the other hand the "working stress of 8,000 pounds per square inch" on iron used for braces of 48,000 pounds ultimate strength per square inch is a "factor of safety of 6." In both cases the figures are determined solely by long experience, since there is no known method by which we can calculate from experiments what is a safe working stress or proper factor of safety.

Since the terms factor of safety and safe working stress are thus seen to be interchangeable, it should be noted that the term factor of safety is a complicated and often a misleading term. It means merely that the safe working stress as found by experience is some particular fraction of the ultimate strength, the ultimate strength being found in some particular way. For instance, the ultimate strength is usually taken from experiments on small sized test pieces, so that in wooden beams the factor of safety if based on the ultimate strength of the small test piece may be taken as, say, 8. Some famous experiments were once made in which the ultimate strength of large wooden test pieces showed a much lower ultimate breaking stress than was exhibited by small test pieces, but the only result of these experiments was

to show that the factor of safety based on the tests of the large pieces could safely be made about 4, while if the factor of safety was based on the small test pieces it should be 8. In other words, designers considered that the safe working stress remained the same whether the large test pieces were used at a factor of 4, or the small test pieces with a factor of 8.

Iron beams show a similar case, though in the case of iron, tests of full sized beams show much greater ultimate strength than the breaking stress as figured from small test pieces. The factor of safety of an iron beam is something like 6 or 8 if figured on experiments on full sized beams, but the safe working stress is found in practice to be the same as when the beam is designed with a factor of safety of 4 figured on the ultimate strength of a small test piece.

This is as it should be, for as stated above, the present designs of beams and boilers, and working stresses or factors of safety, have been worked out by experience, and not by experiment or calculation. The first boilers were of iron made up in "any old way." When they failed, the part that failed was made stronger in the next boiler. When they did not fail the pressure was increased until they did fail, or if more pressure was not needed, then the next boiler was made lighter and cheaper, until finally by means of trial and error the present proportions of boilers have been worked out. The process is still going on, so that undoubtedly boilers will be either cheaper or stronger, or both, twenty years from now. As the proportions of boilers have been worked from experience and by the process of trial and error, it should be clear that the ultimate strength of the material may have nothing to do with the safe working strain, since the ultimate strength may vary without varying the safe working strain. The instances that were quoted above show only that the different modes of determining the ultimate strength may give a different factor of safety for each method, but it is also true that the actual ultimate strength may vary without changing the safe and proper working load. For instance, steel is stronger than iron, and when bridges were first made of steel, it was attempted to use the same factor of safety that had been used with iron, thus making a saving in weight and cost. It was soon found, however, that in spite of the greater strength of steel, its elasticity and the consequent deflection of the bridge under load was the same as for iron, so that to make a proper bridge no saving in weight could be made by use of steel, but instead, the same working stress and a greater factor of safety had to be used.

Further it must be noted that even when we use the working stress, as in figuring the working pressure of boilers or other apparatus, this working stress must be calculated according to the same method in each case, and that the moment there is any change in the conditions we must go right back to experience to tell us the safe proportions for the thickness of metal to be used. For instance, it is customary to take the safe shearing stress on a rivet as about 8,000 pounds per square inch. If, however, we study carefully the ordinary quadruple riveted butt-strap joint and figure not only the average stress of the eleven rivets, but the stress in each particular rivet, we find the single rivet in the outer row must be frequently stressed to something like 20,000 pounds per square inch. We know however that this rivet does not break off, so we conclude that 20,000 pounds per square inch is a safe working stress for this row of rivets, while the safe working stress for the inner rows may be less than 8,000.

These observations indicate how much our real knowledge of boilers depends on the experience of the past with the boilers that have not worked safely, and how little on theoretical considerations.

It is surprising every now and then to find how little we know of the stresses that actually occur. As Stromeyer once pointed out, nothing would seem more obvious and certain than for us to say, when we find a test piece with an area of one square inch standing a load of 60,000 pounds, that the stress is 60,000 pounds per square inch; and yet if we examine the broken part, we will always find that the two broken ends do not fit exactly together; there is a cup in the center that does not match, showing that the center undoubtedly broke first, and must have broken at a stress of something less than the average, while the outside evidently stood more. This is the case even in turned specimens, as well as in rolled specimens where the so-called "skin effect" comes in.

It would appear from this that theoretical calculations were of but slight use—and in fact, as will be shown below, there are undoubtedly cases where theoretical calculations have been of actual hindrance; but on the other hand it must be remembered that theoretical calculations are a means of expressing in a few words or symbols the results of much experience. To say that a working stress of 12,000 pounds per square inch, or a factor of safety of 5, is safe in boiler shells made of steel of 60,000-pounds tensile strength, is a short way of saying that 36-inch shells made of ¼-inch stock, 72-inch shells of ½-inch stock, and 12-foot shells of 1-inch stock, and all the intermediate sizes in the same proportion, appear to be all equally safe. To write all the

sizes and thicknesses would take several pages. To give the rule takes but a few lines; but we must remember that the rule depends solely on experience, and has no particular virtue in itself beyond the experience on which it is based.

Theoretical calculations are also of the greatest importance whenever we would make any change in design or proportions. For instance, we may have two boilers, one of ¼-inch stock carrying safely 50 pounds, and one of ½-inch stock carrying 100 pounds. Theoretical considerations then indicate that if a similar boiler were made of ⅜-inch stock it would carry 75 pounds, and if of 1-inch stock, 200 pounds. In other cases theoretical considerations might show us that the change in safe pressure was proportional to the square or cube of the thickness of the material, and the designer who goes most carefully into all these theoretical considerations is the one who will most quickly improve and cheapen the design. For instance, in the case of thin cylinders such as boilers, increasing the thickness of the shell increases the strength in proportion, but with thick cylinders such as gun barrels, thickening the barrels, after a certain thickness is reached, adds practically nothing to the strength. The theoretical men who worked this out and took advantage of it in their designs saved much valuable time and material, compared with the so-called practical men who found it out only after costly experiment and failure.

In spite of the value of theoretical figuring, it has seemed to me that in boiler design in the past few years there have been cases where too much stress has been laid on theoretical considerations, and other cases where the proper lessons have not been learned from experience, and that a study of boiler explosions would show possibility of improvement. My study has not been so fruitful as I at one time hoped, but a few points which may be of value have been brought out.

The best records of boiler explosions are to be found in the reports of the British Board of Trade, of the German and French Governments, and in the technical press. The reports are made up in several different ways, are often incomplete, and sometimes obviously inaccurate, so that it is hard to draw any statistical conclusions from them; but there are found various groups of explosions due evidently to the same kind of weakness or defect which often teach a valuable lesson.

Cylinder Boilers.—We will begin with a group of a type of boiler now discarded, viz., the old cylindrical boiler 30 to 60 feet long, and some 3 feet in diameter. This boiler frequently exploded at the girth seams over the fire. On considering what happens when this boiler

is under steam the cause is obvious. When first heated the lower part expands and the boiler bows down in the middle, resting its weight solely on the middle support and putting a bending strain on the girth joints. If the supports sink, as they often would, then when the boiler cools down a similar bending strain is thrown on the girth joints, but in a reverse direction. These strains apparently caused the troubles. Most of these explosions, however, appear to have started at the bottom over the fire and not at the top, which is interesting as showing that a seam is weaker in the fire than out of the fire.

The longitudinal seams of these boilers also gave way in some cases, most of the cases being seams over the fire which had leaked and been caulked or patched. This type of boiler has been discarded but its explosions have shown two important lessons; first, to take care of expansion; second, to avoid seams in the fire.

Water Tubes.—We will now turn to the most modern form of boiler, viz., water-tube. As is well-known, the explosions of this type of boiler are far more frequent in proportion to the number in use than in any other well built type, but on going over the list, it appears that the explosion consists almost always in the blowing out of a tube in the lower row, seldom doing much property damage though frequently one or more lives are lost. These tube blow outs appear in many cases to be due to defective welds, in others to thinning of the tube due to corrosion, or to overheating, caused by scale or oil.

The lessons to be drawn are; first, of course, to get better material or weldless tubes; second, to be careful and thorough about cleaning from scale; and third, to take efficient measures to avoid the presence of oil in the tubes.

The Mutual Boiler Insurance Company's investigation and study of thick boiler plates a few years back also indicates a possible improvement. Suppose instead of using the 10-gauge tubes now used, a much thicker, say 4-gauge, tube were used in the lower rows. As has been shown in the investigation on thick boiler plates above referred to, thickening the tube by this $\frac{1}{8}$ inch would increase the working temperature of even the outside by but a few degrees. It would, in fact, decrease the temperature of the inside by a very small amount. This thicker tube, therefore, should give no more trouble from overheating than the present thin tubes, while it should last much longer under corrosion, have a much better weld, and when overheated or strained in any way, should be much stronger than the thin tube.

The study of these explosions also indicates that the tubes in the upper rows may be unnecessarily thick. The fact that it is only the

tubes in the lower rows that give much trouble shows that those in the upper rows are certainly strong enough, and probably too strong. By "too strong" is not meant that any part of a boiler can be really too strong, but since the total cost of a boiler is limited, the extra money spent on making the upper tubes stronger than need be means that the money thus wasted could have been used to make the lower tubes still stronger.

It is now the custom of the water-tube boiler companies to use, I think, 12-gauge for pressures under 125 pounds, 10-gauge for pressures from 150 to 250 pounds, and 9-gauge for pressures from 250 to 350 pounds. Supposing, instead, that for pressures under 250 pounds they used 12-gauge in the upper rows and 6-gauge in the lower rows. Their boilers would be both cheaper and safer.

Internally Fired Boilers.—Another group of explosions is formed by the cases where the furnaces of internally fired boilers, such as the Lancashire, Cornish, and marine boilers, have collapsed. These explosions seem very seldom to be due to weakness, but always to overheating, whether caused by actual low water or by scale or oil. One marked difference is apparent of late years in that the more modern furnaces—whether because they are built of better metal, or on account of the superiority of the design in the use of Adamson rings or the various corrugated types, such as Fox, Purves, Morrison, etc.—are less apt to split or break or tear at the seams, but often bag down without causing loss of life or of other property than the furnace itself. Likewise short furnaces, such as in marine boilers, appear less liable to disastrous explosions than the long furnaces such as are found in the Lancashire type.

The indications for better practice are clearly in the nature of care in the operation against overheating, and the use of the modern designs of Adamson rings or corrugations.

Lap Seams.—Another group of explosions appears to be due to cracks or grooves under the lap of the horizontal seam in lap-seam boilers. These cracks as often as not do not pass through the rivet holes, but appear in the solid plate. This would indicate that the design of the seam puts undue bending stresses on the plate near the seam. This weakness is particularly dangerous, since it cannot be found by inspection in the many cases where the crack is covered by the lap. The fact that no boiler built with a butt joint and double covering strip has ever exploded by reason of any weakness at the joint shows that the way to avoid explosions from this cause is to avoid the use of lap joints in the horizontal seams.

Elephant Boilers.—Another group of explosions is found among the class of boilers known as the French or elephant boiler, consisting of two or three small drums 18 inches or so in diameter, connected by necks to a larger drum above. The small drums often fracture, occasionally in the seam but more frequently in the solid plate, the plate usually showing signs of overheating or corrosion or both. Such overheating cannot of course be caused by low water, since the upper drum, which is also exposed to the fire, would in case of low water give out long before the lower ones. The overheating is obviously due to poor circulation, since the moment circulation is checked for any reason so that steam issues from both necks of the lower drum, a steam pocket would be formed in the lower drum and the plate would be overheated. The indication for improvement is of course to change the design so as to insure good circulation, and to increase the thickness of the plates of the lower drum so that they will stand longer under such overheating and corrosion as cannot be prevented.

Lancashire Boilers.—Another group of explosions occurring in boilers of the French type, and also in the Lancashire and Cornish boilers, is evidently due to corrosion where the drums or shell come in contact with the brickwork. Some brickwork, as is well-known, is acid and will corrode under almost any circumstances, while any brickwork will take up moisture when the boiler is cold, and cause corrosion.

The indication for improvement is of course to change the design so that the shell does not come against the brick. One way of doing this would be to take a piece of tank steel, or even cast iron, and rivet it onto the shell at the point where it was to come into contact with the brick. Such a piece riveted on would take up the corrosion without weakening the boiler. In American practice there are cases, such as the brickwork on top of a horizontal tubular boiler, or the brickwork around the furnace door, where a similar corrosion would seem to be possible. The fact that corrosion does not seem to occur in these circumstances shows that for these cases no change in design need be made.

Cast-Iron Headers.—Another group of explosions is that due to the cracking of cast-iron headers of some forms of water-tube boilers and sectional boilers. Modern good practic is opposed to the use of cast iron under tension. This objection is not due to any lack of strength in the metal, since lack of strength can always be made up for by increased thickness. The trouble with cast iron is its lack of

ductility. A boiler plate or stay bolt or rivet is by reason of temperature or other changes often exposed to a stress much in excess of the elastic limit, but gives slightly and permits the load to distribute itself. A brittle material, however, such as cast iron, breaks before it will give enough to distribute the load. Cast iron therefore should not be used except in such portions of the boiler as are expected to be absolutely rigid under all conditions.

Hand-hole Covers.—Another group of explosions is due to the breaking of some portion of the device used to close up hand holes or man holes. In some designs the plate is placed inside the boiler so that the boiler pressure keeps it tight, and except for leaks there is no trouble. This however involves ellipitical holes, or some equivalent device so as to get the cover inside the boiler. If circular holes are used with the cover outside the boiler, then a breakage of the holding device, or corrosion of the bolt, will permit the cover to be blown off. Several accidents have happened from this cause, the worst cases being where the attendant was engaged in tightening the bolt and the extra strain due to the tightening caused the break and the attendant was killed or badly injured as a result. While the form with outside cover is in some ways more convenient, yet the greater safety of the inside cover would indicate the latter form as preferable. The use of an outside cover with a cast-iron holding device is particularly dangerous.

Reverse Flanges.—Another group of what would have been explosions if our inspectors had not discovered the cracks in time is found among the vertical tubular boilers provided with a so-called expansion joint or reverse flange. Theory shows that these flanges are weak under steam pressure, particularly so in the designs first made, in which the flange was thin and had a large flat surface. Of course to fulfil its purpose of an expansion joint it should be thin and wide, but as a matter of experience, vertical boilers without the flange, but with long tubes, show no more leakage at tube ends than the boilers with the expansion joint. The lesson thus indicated by these cracks is either to avoid the use of the reverse flange entirely, or, if the flange is used, to make it thick and to give it a good radius of curvature.

Small Vertical Boilers.—Another very interesting group of explosions is found among the small vertical boilers used in England. These differ from those used in America in that instead of numerous small tubes of 2 inches or 3 inches diameter, one large tube or flue of some 12 inches to 24 inches diameter is used. Frequently water

tubes called "cross tubes" are inserted horizontally across the single large flue.

Many of these boilers have exploded by collapse of the furnace, and at first sight this would appear to be a sign of weakness; but examination of the reports shows that the explosions are not due to weakness of design or construction but to abuse. These boilers are used for farm and miscellaneous purposes, are sold and resold second-hand without proper examination, left to rust in yards for months or years, and run by ignorant workmen. Larger boilers of the same type would receive much better care, while small boilers of other types are seldom used. The reports of the explosions show for instance "the plate was corroded to 1-32 inch thick." "The plate was corroded to the thickness of writing paper;" "the plate in adjoining portions which had not collapsed was so thin that a slight blow of the hammer would go through it." Explosions under such circumstances are not a sign of weakness of design, but they are a most powerful argument for frequent and thorough inspections.

The furnaces of these English boilers do not appear to be stiffened by stays as is the custom in most American boilers of the corresponding type. It is possible to make out a good argument showing that stays will weaken a boiler of this type unless sufficient stays are put in to make the flue as strong as, or stronger than, a flat plate of the same thickness. This theory, however, neglects the fact that stays and plates will give a little and divide up the load before they will break, and the fact that many small boilers whose stays alone or flues alone are much too weak for good practice, are running in America without giving any trouble, shows that the stays and flues do help each other. The absence of trouble is not due always to careful management, since I believe it has been said that part of the outfit of some hoisting engineers (and such boilers are almost always used on hoisting outfits) consists of a lump of iron to hang onto the safety valve when the regular pressure will not start the load.

These remarks on staying have taken us a little off the track of the explosions we were considering. The means for preventing the explosions of this class are obviously careful inspections. The use of thicker plates in the firebox will also diminish trouble and permit less frequent inspections than when thinner plates are used.

Thicker Tubes and Plates.—In the case of the tubes of water-tube boilers, the furnaces of internally fired boilers, and in one or two other cases, the opinion has been expressed above that thicker tubes or thicker plates would diminish the number of explosions. As this

view is opposed to some former views and rules which forbid plates of more than a stated thickness the point should be clearly understood.

In the first case, the experiments on which the so-called factors of safety of water tubes and furnace plates are based have all been made cold at much higher pressures than occur in practice, while the records of explosions show that the troubles occur at pressures only slightly if at all above normal working pressure, but under conditions of overheating or corrosion or both. Greater protection against injury from corrosion is obviously obtained by making the tube or plate thicker and about this no argument is necessary; but there has been a feeling that thickening the tube or plate would increase rather than diminish the danger from overheating.

Let us however think of the thick tube as made up of two thin tubes of ordinary thickness perfectly welded together all over the surface, and compare this with a single thin tube. It is obvious that the inner tube of the pair that make up the thick tube can be no hotter than the single thin tube, and must be at least as strong. The outer tube of the pair will of course be hotter than either the inner one or the single thin tube, but so long as it is cool enough to retain any strength the pair of tubes that make up the thick tube will be stronger than the single thin tube.

The shells of externally fired boilers are made up to 9/16 inch thick and the furnaces of marine boilers to 5/8 inch or more without showing sign of deterioration of the outside, hence the tubes of water-tube boilers could be made up to that thickness if desired and each increase of thickness would add to the strength.

The prejudice against thick plates probably arose from the following reason. When wrought iron was in use, the thicker plates were not equivalent to thin plates perfectly welded together, but the slag in the wrought iron made non-conducting layers or laminations. A homogeneous 3/8-inch plate, as we have seen, is always stronger than a 1/4-inch plate, and practically 50 per cent. stronger. If however there should be a nonconducting layer 1/16 inch in from the water side, this would form a blister and permit the 5/16-inch outside portion to get overheated and weakened, and the plate would fail where a 1/4-inch homogeneous plate would have stood. On the other hand, however, if the blister had formed 1/16 inch in from the fire side, it would have left 5/16 inch of good metal which would have stood even better than the 1/4-inch plate, since protected from the fire by the blister. It is very possible that many plates have actually been unnecessarily weakened by cutting out such blisters that were close to the

fire side, leaving plenty of good metal, in order to patch. In the case of good homogeneous steel such as we are now getting, the trouble from blisters and laminations has almost entirely disappeared, and whenever we desire to increase the strength of a plate we can do so by increasing the thickness though we cannot count on the strength increasing in full proportion to the increase in the thickness.

For cases of very thick plates and for cases where seams are in the fire other considerations might come in. There might also be cases where the greater flexibility of thinner plates was important.

Manholes and Domes not Re-enforced.—Another group of explosions of some interest includes the case where the initial fractures are found radiating from manholes or steam drums. Modern methods require of course the re-enforcement of such openings, but it is interesting to note how this requirement has been worked out by experience and not by theory. A boiler plate with 40 per cent. cut out for rivet holes is credited with 60 per cent. of its original strength, while if only 10 per cent. is cut away for a manhole opening it is considered dangerously weak because it has been found so by experience.

Groups of Explosions that have not Occurred.—While the study of actual explosions leads to many points of interest, yet it must be remembered that until the time comes when price is literally no object it will always be possible to make a boiler too strong in some part. It is not that the excess of strength is itself objectionable, but that by lightening that portion the metal or expense thus saved could be used to strengthen the weaker portion. If therefore some portion of a boiler type has never given any trouble the probability is that it is unnecessarily strong. Following out this line of thought we may consider some groups of explosions that have not occurred.

Butt Joints.—One of these of much interest is the question of butt joints with double covering strips. Such joints have I believe never given any trouble; certainly no cases of explosions are found due to weakness of such joints. It therefore follows that they are amply strong, and that there is no need to make them stronger. Hence the triple-riveted type, being strong enough, is preferable to the more expensive quadruple joint. The pitch of rivets for greatest theoretical breaking strength is greater than the pitch that gives the best caulking pitch, but this greater theoretical strength by using a large pitch may properly be sacrificed as unnecessary in order to get a tighter joint by using a closer pitch. This is a case where theory has probably done actual harm to boiler design. A formula that made the pressure depend solely on the efficiency of the joint would

permit a greater pressure on the wide pitch and would encourage the boiler maker to use the wider pitch, although the boiler would actually be of poorer design than if it had a closer pitch.

Staybolting Circular Flues.—Another group of explosions that have very rarely occurred is that due to trouble with the staybolting of vertical boilers of the Corliss or Manning type with circular fireboxes. The stay-bolting of these circular boilers has usually been figured on the same basis as flat plates, but this is not necessarily correct. First of all we have the strength of the flue as unsupported by any stay bolts. The stresses due to external steam pressure on such a flue correspond closely to the stresses on a strut or column, or, to take a more familiar case, to the stresses on the wood of a bow used for shooting arrows. So long as the column or bow is perfectly straight the stress due to the load or bowstring is compression simply (assuming in the case of the bow that the string could be made to pull in line with the axis). If the column or bow is not perfectly straight, then even a slight pressure will cause it to bend slightly, though it will not collapse. As soon, however, as the load reaches some limit—depending on the elastic strength of the material—the column buckles and collapses. The load on the column, or steam pressure on the flue, at which this happens depends largely on just how closely the pressure is in line with the axis of the column, or in the case of a flue on how perfectly the shape approaches the circular form. It depends also, of course, on the thickness of metal and on the length of the column or the diameter of the flue.

If the flue is supported by stay bolts, as in the type of boiler referred to, then we have the following state of affairs. The outside shell of the boiler expands slightly under the pressure due to the elasticity of the metal. The inside flue compresses under the pressure, these movements tending to elongate the stay bolts. The stress on the stay bolts therefore tends to throw the flue into a polygonal form, and we must consider it in two lights—first, as regards the portion between stay bolts, and second, as regards strength against collapse as a whole. Unless the stress on the stay bolts be sufficient to make the portions of the plate between stay bolts absolutely flat, they will remain in the condition of a dished head or arch under compression, and will be consequently stronger than a flat plate. If the stress be sufficient to make them absolutely flat, they will then be as strong as a flat plate.

When we come to consider the question of the collapse of the flue as a whole, which is now polygonal instead of circular, it is obvious

that so long as the individual arcs between stay bolts do not collapse the polygonal flue will be as strong as the circular flue, if the polygon is symmetrical.

Even if the polygon is not symmetrical it is still as strong as before, provided that it is as symmetrical as before, and must be stronger than an un-stay-bolted flue, since before it can collapse the stay bolts must break or pull out. If, however, the stress on the stay bolts should be such as to make the flue less symmetrical than before (as might easily happen if the outside shell were other than circular, or in the case of an horizontal flue with a fire inside), then the stress on the stay bolts might weaken the flue.

The general result of these stresses may now be summed up as follows:—

Stay-bolting a circular flue or furnace to the surrounding circular shell will add to its strength against collapse as a whole.

Stay-bolting a flue to a circular shell will make the individual portions of the flue between stay bolts more liable to collapse than if not stay-bolted, but they will still be stronger than a flat plate.

Now in very large boilers—say 6 feet diameter—the arc between stay bolts is nearly flat even without the stay-bolt stress; hence when the stress on the stay bolts makes it still flatter, it approaches closely to the flat plate and the pitch of the stays should correspond to that required for a flat plate, though it need not be quite so close a pitch. Just how closely this pitch should approach the pitch of stay bolts required for a flat plate can be learned best by experience.

On small boilers such as those with flues about 36 inches in diameter, where the arc between stay bolts has a considerable curve, the pitch between stay bolts need not be as small as required for a flat plate. The size of the stay bolts must also be considered as well as the pitch.

In both cases, both large and small flues, the stress on the stay bolts cannot be exerted until the flue itself is compressed by the steam pressure, on account of its circular form; hence the stress on the stay bolts will not be as great as with a flat plate, and in neither case need the size of the stay bolts be as great as is needed with flat plates.

It is possible of course to figure out a very excessive stress on stay bolts if we omit the essential consideration that a stay bolt can give slightly under stress and still exert its full strength. For instance, supposing that the stay bolts and inner flue were of brittle inelastic material while the outer shell was elastic. Then the stay

bolts would take the whole stress due to the steam pressure, and the stay bolts would take the stress corresponding to the pitch of the stay bolts on the outer shell. According to the same theory if one stay bolt should be a shade, say $^1/_{1000}$ inch shorter than the others, it would take the full load and be stressed beyond its breaking limit while the others would not be strained at all. What actually happens, of course, is that the stay bolt is strained beyond its elastic limit and gives a little and then the other stay bolts take up their share of the load, and in the case of the circular flue with stay bolts there is enough play and give to the metal to divide the load.

Just how much advantage can be taken of these facts is a question that can best be determined by experience, but the fact that we so seldom find any trouble of any kind in the stay-bolting of these circular flues indicates that we can safely lighten up the stay-bolting to some extent.

The foregoing notes are disconnected and incomplete, yet it is hoped that they may bring out a few points of interest and importance. The most important part of all is that while theoretical calculations are of value, yet they must be checked up all the time by the results of experience. A bicycle manufacturer can work out his proportions by noting how many times his bicycles break down. A boiler maker cannot use the process of trial and error to the same extent, but should take advantage of all the records of boilers that have failed and boilers that have not failed to find out where any improvement can be made. The most important thing is not to design a boiler with a given factor of safety (I think it was Holley that used to call it a factor of ignorance) but to find out the factors of safety which may be 2 and may be 50, or rather the working stresses in the different parts that will give the best possible boiler for the money.

WHAT MANCHESTER IS DOING FOR ENGINEERING APPRENTICES.

By F. Brocklehurst.

The thorough examination of the apprenticeship question, contained in the series of articles of which this is the fifth to appear in this Magazine, includes the study of the subject from the standpoint of the shop superintendent, the independent trained mechanic, and the technical educator.

The first-named aspect appeared in the accounts of the Westinghouse, Brown & Sharpe, and Allis-Chalmers systems in our issues for December, 1903, and January and April, 1904. A very valuable exposition of the methods of the Baldwin Locomotive Works, inspired and directed by Mr. Vauclain, will follow in June, having been completed just too late for publication in this number.

The interesting suggestions of Mr. E. P. Watson, in this Magazine for February last, expressed the views of the independent expert shopman and mechanical engineer. The article now presented shows the British conception of the possible functions of the technical trade school in co-operation with the employer. The American idea of the same question will be summed up in a contribution from Mr. Frank T. Carlton, on "The Industrial Value of Manual Training," in a following number of the Magazine.—THE EDITORS.

IT is not my intention to attempt to describe all that is being done in the city of Manchester for the advancement of commercial and technical education. I shall merely try to show what the city authorities are doing, singly and in conjunction with the Victoria University of Manchester, to raise the status and to improve the education of electrical and mechanical engineers. It will not be necessary to remind the readers of this Magazine of the fact that a little over a year ago a great school of technology which stands unrivalled in Great Britain was opened in the city. The object of the school has been well expressed as being to accommodate the mechanical, electrical, and sanitary engineering industries; the chemical and textile industries; architecture and the building trades; and printing and other trades and industries. It is a serious attempt to place at the service of English industry an institution which shall be adequate to its needs and importance and comparable in respect of equipment with the great institutions of the Continent and the United States.

The Manchester School of Technology grew out of the old Technical School, which in turn was the product of a one-time Mechanics Institution. These changes of name are all significant. The alteration from the title "Technical School" to "School of Technology"

was accompanied by a raised standard of examination for day students, and by the determination of certain courses of study which in the absence of degree-giving power will be rewarded by diplomas. On the recommendation of the board of studies of the institution it was decided that the matriculation or preliminary examinations of recognised British Universities, and the higher certificates of the Oxford or Cambridge Schools Examination Board, or the Oxford or Cambridge Senior Locals Honours, should be accepted in lieu of the entrance examination thus determined upon. This increased standard of examination was fixed in the full knowledge and expectancy that at the outset it would have the effect of reducing the number of day students, but it was believed that what the school would lose in numbers it would gain in the quality of its future students. Concurrently with these changes the staff of the school was strengthened, and the title of professor was conferred upon the heads of its several departments. At the present time Professor J. T. Nicolson, D. Sc., late professor of mechanical engineering at McGill College, Montreal, is in charge of mechanical engineering and receives the able assistance of Mr. H. G. Jordan, the professor of mechanics and engineering drawing, as well as of a number of other lecturers and instructors. Professor Schwartz, A. K. C., is at the head of the electrical-engineering department and also occupies the post of professor of physics and electrical engineering. His coadjutor in this post is Mr. W. W. Haldane Gee, B. Sc., Lond., who is professor of pure and applied physics.

The equipment of the school is of too elaborate a character to lend itself to detailed description in these pages, but with respect to the special subjects under consideration it has been well said that the object aimed at in the mechanical-engineering section is fourfold:

1.—The teaching of engineering science as much as possible by experiment.

2.—The determination of the technological properties of the materials of engineering.

3.—The instruction of young engineers in the usual and best modes of testing prime movers, the machinery of transmission and the machinery for the absorption of energy.

4.—The provision of facilities for experimental work under the direction of the engineering staff on the present-day problems of engineering design.

The electrical-engineering and physics department contains two lecture rooms fitted with electrical experimental projection lanterns; four laboratories for work in physics and electro-technics; two dynamo

and motor-testing rooms; a standardising laboratory; a high-tension room; electro-chemical engineering, photometric, and optical laboratories, together with instrument-testing, cable-testing, and accumulator rooms.

The authorities in charge of this institution are fully cognisant of the fact that its ultimate usefulness and success rest entirely upon the complete organisation of a sound system of secondary education, without which no adequate scientific technical and artistic training especially for the leaders of our industries is possible. With these considerations in their minds they have recently determined upon the transformation of a higher grade school and school of science into a modern secondary school. These buildings are in close proximity to the School of Technology and it is confidently expected that the newly organised secondary school will form a valuable feeder to its larger neighbour. It is hoped that by a suitable arrangement of fees and the creation of a number of bursaries, the professional and business men of the city who desire to give their children a good education, extending until at least 16 or 17 years of age, will take advantage of the new means thus afforded as a preliminary to a technological course in the School of Technology. The courses of instruction in the new school are designed to extend the pupils' knowledge of their mother tongue so as to secure greater facility and accuracy in its use and a wider acquaintance with its literature. It is also intended to devote greater attention than has hitherto been the case to the important subjects of geography and history, to give an effective training in foreign languages not excluding Latin, to give a sound training in the elements of mathematics and in the general principles of science, and, in addition, to give systematic instruction in the use of tools and in drawing. There are at the present time 1,386 boys and girls in attendance at the Central Municipal school, of which number 478 are in the second division. The ages of the latter range from 12 to 16. Of the 478 already mentioned 390 are boys.

In the School of Technology itself there are at the present time no fewer than 2,016 enrolments in the electrical-engineering department, but the actual number of pupils is somewhat less, as some of the pupils are enrolled in more than one class. In mechanical engineering there are 1,620 enrolments. The day students are of course very considerably less in numbers. There are 83 students following the first year's course, which is of a general character. The subjects of this course are mathematics, English, German, geometrical and engineering drawing, mechanics, physics, and chemistry, including

laboratory work in each of these three sections, and wood-working exercises. At the end of the first year the student specialises according to the profession which he hopes to follow. In the second year's course for mechanical engineering there are 27 students, while 37 are taking classes in electrical engineering. It must be admitted that these numbers are far from satisfactory, but they are not discouraging in view of the fact, previously recorded, that the authorities of the school have raised the whole standard of their education and examination, and have thus made the doorway of entrance considerably straiter. They are at the present time taking important steps with the object of making the benefits of the school more widely known, hoping thereby to attract a considerably augmented number of pupils. Partly with this object in view they recently called upon a large number of employers in the districts in which the subsidiary institutions are situated, with the object of persuading them to give facilities to their apprentices to attend evening classes therein. The result has been most satisfactory. The numbers attending have been augmented and in many cases the employers have paid their apprentices' fees.

The growth in the number of day students does not proceed at the same rapid rate. A valuable experiment was made by a local firm, which unfortunately has not been followed. The firm in question sought to combine the theoretical training of the school with the practical experience of their own workshop, and with these objects before them they selected the most promising of their apprentices and paid his fees at the School of Technology, and, in addition thereto, paid him the wages he would have earned had he remained at work. The arrangement they made with the school and their apprentice was that as often as the school was open he should attend classes, but that during vacations he should return to the workshop. He was in fact to be a regular day student throughout the session. A scheme having for its object the relief of deserving apprentices from the arduous conditions of evening study has lately been put forward by Mr. J. H. Reynolds, M. Sc., the principal of the institution. Circulars were issued to engineering employers far and near inviting them to send certain selected apprentices on one day in each week to the school. This circular was well received. A conference was held with the Manchester Association of Engineers last October, and the final outcome was a scheme of which the following are the chief features: the apprentices selected by the employers are not to be below the age of eighteen years; they must be possessed of a knowledge of the ele-

ments of mathematics and drawing, and be of such good character in respect of conduct and capacity as to deserve the privilege offered. The course of study commences each Monday at 9.15 and continues to 1.15. A break of three-quarters of an hour is allowed for lunch, and studies are then resumed from 2 to 6. These comprise mathematics, lectures on engineering, laboratory exercises, and the teaching of mechanical drawing. The instruction imparted is made as advanced in character as the educational condition of the student permits, and the fee for the complete course is fixed at 30 shillings. These apprentices are not expected to attend evening classes. Each Monday afternoon sufficient home work is given them to last for the remainder of the week, and on the succeeding Monday this work is reviewed by Professor Jordan, who is in charge of this department, and marks are given in accordance with the result. Monthly reports of his attendance and progress are furnished to the employer sending the apprentice. Absentees are also to be reported at once, but up to the present time such cases have not arisen. The reason for this, apart from the attractiveness of the course itself, is that a selected apprentice who is absent from these Monday day courses loses his day's pay.

At the present time seventeen firms have amongst them sent forty students, and Mr. Reynolds says that this number is as many as can conveniently be accepted without a further increase of staff. As previously indicated, the wages of these apprentices are paid by the firms sending them, and in some cases their fees are also met from the same source. The great merit of the arrangement is that it relieves students who are otherwise working all day from the severe work of evening studies. Some of the applicants for permission to attend these Monday day classes in engineering had to be refused because they were not sufficiently advanced to take proper advantage of the studies. The present course ends with the close of the school academical year in July. If the employers are willing to allow these apprentices to attend a second year, the authorities of the school will select the best of them for a further year of training in more advanced subjects. An examination will be held at the end of the session by their respective teachers which will show the relative positions of the student, and those who have not shown aptitude for their work will be weeded out. These Monday classes are primarily intended for apprentices who it is hoped will in due time become foremen of departments. The scheme is at present confined to engineering apprentices; still, there is nothing to prevent a similar course of

study being taken up by apprentices in other industries. The example is certainly well worth following.

Whilst the authorities of the Manchester School of Technology have, in the manner already indicated, taken steps to improve the education of working apprentices, they have by no means been neglectful of those who are destined to become heads of department, managers, and employers. As Mr. Reynolds said to me the other day, the crux of the whole matter is the education of the employers. As he expressed it:—"We all want, it is true, to do whatever we can for the rank and file, but if you can get the employers educated they in turn will look for better trained men about them than those they have at present." If the bulk of the employers were really technically trained men they would undoubtedly ask for similar intelligence in their employees. It must be confessed that at the present time they look down upon the technically trained student. They allege that if they ask him to do anything he finds that he has forgotten his formula. This is of course a mere libel, and it presupposes a misconception as to the real objects of schools of technology. These schools are not designed to turn out engineers. They were never meant to do this work. All that they were ever intended to do was to turn out men who should make good engineers. I have already suggested that with the object of attracting students who are likely to be in positions of responsibility, the School of Technology established three-years courses for day-students in mechanical engineering, electrical engineering, technical physics, and other technical subjects, and as at present arranged the diploma of the school will be awarded to those students who satisfactorily fulfil the conditions of this course. The Manchester Corporation had scarcely determined upon the creation of this three-years course with its consequent diploma when an agitation emanated from Liverpool, having as its object the dissolution of the Victoria University into its three component elements. Following upon the applications made to the Privy Council, new charters have been conferred upon the Colleges of Manchester and Liverpool and an application is now before Parliament to do the like for Leeds.

This was a splendid opportunity for the Manchester people and full advantage was taken of it. In response to their representations, the charter of the Victoria University of Manchester contained a provision for the institution of a faculty of technology, and by an agreement which has been entered into between the Corporation on the one hand and the university authorities on the other, certain day-courses of the Technical School are to qualify for degrees in the Victoria

University of Manchester. It should perhaps be explained that the new universities are not like the old Oxford and Cambridge Universities of which the constituent elements are colleges, but on the contary are constituted of faculties, such for example as the faculty of arts, medicine, law, etc. Two of the latest faculties to be created in Manchester are those of commerce and technology. The faculty of technology has not yet been fully established. It is still the subject of negotiation between the Corporation and representatives of the university, but certain of its broad outlines have been agreed upon. Certain subjects taught in the day-courses of the school of technology are to be within the purview of the faculty. These have not yet been definitely decided upon, but it is almost certain that amongst them will be found mathematics as applied to technical subjects, mechanical engineering, applied chemistry, and applied physics. The members of the board of faculty are to be such of the present members of the board of studies of the School of Technology as are engaged in the teaching of the subjects previously referred to, together with five or six representatives of the University. The present members of the board of studies of the School of Technology in the subjects of the faculty who are not nominated professors of the university will become lecturers. There will be a matriculation examination which will be regulated by this joint matriculation board. At the completion of the three-years course degrees in technology will be conferred upon successful students. As will be readily understood the day students of the school of technology who take this degree course will be members of the Victoria University of Manchester and will be required to conform to its discipline, by-laws and regulations. For all practical purposes this happy arrangement between the Corporation of Manchester and the Victoria University constitutes the School of Technology an integral part of the university so far as its day courses in the subjects enumerated are concerned. As I have already explained, the full details of this working arrangement have not yet been decided upon, but it is the hope of those interested in the question that in some way or other honours degrees may be obtained in technology. The proposal that meets with the greatest acceptance at the moment is that at the end of a three-years course for the ordinary degree, a student in technology should be required to do an amount of independent research work covering a period of another academic year, at the end of which time he should be called upon to write a thesis, and that such post-graduate work and thesis should be the qualification required for a degree in honours.

I have already given the number of evening students in attendance on the courses in mechanical and electrical engineering in the Manchester School of Technology (the number of *individual* students enrolled in the institution exceeds 5,000) and have also indicated the character of the work done by those selected apprentices who attend the engineering classes on Monday. For these students opportunity should be afforded of crowning their educational work with a degree, and I have reason for saying that steps will be taken in the near future with that desirable end in view. It is recognised that those students who are permitted to seek this honour should be men of high intelligence and also be possessed of a broad general education of a secondary character. With qualifications of this nature there is no reason why they should be denied the privileges which are readily conferred upon those students whose means permit them to attend the regular day courses of a university. A five- or six-years course at an evening school is surely an equivalent of a three-years course during the day. No pains will be spared to secure university recognition of the evening students in technology in Manchester. If this recognition cannot be obtained locally students will seek it elsewhere, since the University of London, by the terms of its charter, can accept for its external degrees any duly prepared evening student.

Enough has been said to show that the city of Manchester is fully alive to the importance of the industrial problem which has been created for Great Britain by her Continental and American rivals. As I have already indicated, the solution of the problem has been sought along educational lines, and in this pursuit the city has not only erected a magnificent school of technology and equipped it with machinery and staff second to none in the country, but has also endeavoured to fill the gap which unfortunately lies between the primary and technological schools, to increase the number and to raise the status of the pupils at the latter institutions, and to enable the study of science as applied to industry to take equal rank as an educational instrument with those subjects of study which find special favour in the ancient British universities.

EDITORIAL COMMENT

WITH a somewhat quieter home demand for engineering manufactures than has been experienced for a few years past, the attention of American builders of machinery and tools is likely to turn again more actively to foreign markets. Since the last great occasion six or eight years ago, when the search for an outlet abroad was so general and so keen that Europe took fright at the "American Invasion," our manufacturers have kept a foothold in and a watchful eye upon that field, if not more. But as Mr. Clark so well says in his leading article in this issue, "America itself is by far the best market of the world for manufactured products; consequently it is not strange that up to the present American manufacturers should have devoted their principal attention to home trade." The foreign field was a surplus market, rather than one of first selection. And scarcely had the outposts been well established, when the home demand leaped to such figures that the more distant campaign lagged, for want of sufficient motive to push an advance.

If now, as seems possible, the overpressure of the nearer demand may slacken for a time, export trade will reassume importance in the calculations of American managers, especially as the conditions abroad (which have been far from inflated during the time of our own home activity) are looking more promising for an expansion of business. From Germany, which has long been in the depths of depression, come most encouraging reports of reviving business and busy shops. The market conditions of the last decade, at home and abroad, afford the most suggestive and instructive example possible of the compensating effect of foreign trade and the stability which may be given to a manufacturing business by the cultivation of an export market.

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ONE significant point is to be noted in the prospects of the immediate future. When conditions advance the foreign market to a position of greater relative importance to our manufacturers, we shall open the campaign of renewed activity from a vastly more advanced stand than that which formed the base of the preceding "invasion." In conception of the possibility of doing business abroad, in the knowledge of the market and the buyer, and—by no means least—in prestige and standing in the eyes of the world, the American machinery and tool manufacturer gained a long lead then, and in any further effort will start from that advanced position. And, on the other hand, our foreign competitors has been a proficient student of many of the very things which won us our early victories, and the difference in weapons, on the mechanical side, has been and is being leveled up. Our prime need is the development of a commercial system equal in excellence to our manufacturing system. Mr. Clark's article is an invaluable contribution to the most important study of the day.

DURING the past few years there have been various commissions, commercial, industrial, and educational, sent from different parts of Europe to investigate and report upon the methods of doing things in the United States. All such visiting parties have been welcomed and aided in their work, American engineers and men of affairs having most appreciative recollections of courtesies received in various parts of Europe upon similar occasions abroad. The present year will be especially full of affairs relating to what may be called the social side of the engineering profession, since announcements have been made of a number of visits of European engineers to America.

The first of these visits will be made during the present month by the Institution of Mechanical Engineers, a large party, including the president and the secretary, having arranged to come to the United States to hold their convention at Chicago, in conjunction with the American Society of Mechanical Engineers. This is a most welcome return of the joint convention held by the same societies in London in 1900, and there is every reason to believe that the meeting will be productive of most valuable professional and international results.

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THE next visit in point of date is that of the Société des Ingénieurs Civils de France, of which society a representative body will sail in the latter part of August. While no especial professional meetings have been arranged at that time, there is no doubt that the French engineers will receive a hearty welcome, not only during their local visits, but also at the exposition at St. Louis. We have a most pleasant recollection of the visit of the members of this society in 1893, and it is especially appropriate that they should attend the celebration of an important event in the international relations between France and America.

The visit of the French engineers will be followed closely by that of the Institution of Civil Engineers, and this party, like the members of the French society will devote itself mainly to a tour of inspection and recreation. While they will be the guests of the American Society of Civil Engineers in a social manner, we understand that no joint professional sessions have been planned.

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THE Iron and Steel Institute, arriving in America in the latter part of October, will hold its own convention in New York, after which an extended visit will be made by the members to various parts of the country, and doubtless many of the visitors from all the societies will spend a portion of their time at St. Louis.

In all there will be between 1,500 and 2,000 visitors from England and the Continent in this country between May and November of this year, and American engineers in all parts of the country will have the opportunity of welcoming their friends from Europe, and of reciprocating the many hospitalities which they themselves have received while abroad.

Already plans are being made for the reception of the visitors, and local committees are being formed in the different cities and districts where visits are anticipated, and there is no doubt that every facility will be afforded to the members of every branch of the profession to see what is being done in their various lines of work. American engineers have always been made welcome abroad, and now it is their turn to greet their friends and colleagues.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

GRADUATE APPRENTICES.

SUGGESTIONS FOR THE IMPROVEMENT OF THE POSITION OF THE TECHNICALLY TRAINED APPRENTICE IN THE AMERICAN RAILROAD SHOP.

W. F. M. Goss—Western Railway Club.

IT is generally appreciated at the present time that the true way for a nation to benefit by its opportunities in connection with technical education is to provide for the proper connection between the school and the workshop, so that the young graduate may be given full opportunity to make his theoretical training of value, from the start, both to himself and his employer. In this respect the United States is undoubtedly in advance of Great Britain, since no money premiums are required by the employers, and in most cases a living wage is paid from the start. So much has been said from the favorable side of this question that it is wise to give all phases of the matter thoughtful attention, since it is only by the joint education of employer and employee that the greatest benefit can be secured.

For this reason the thoughtful address of Professor W. F. M. Goss, recently delivered before the Western Railway Club demands attention. The fact that Professor Goss is connected with Purdue University, and has therefore most excellent opportunities of knowing the relations between technical graduates and the leading railway companies of the United States, lends especial value to his opinions.

The general idea underlying the relation of the technically trained graduate to the ordinary apprentice is that he is far better fitted to learn than is a young man who has not had the advantages of a higher education, and that therefore he can readily acquire the practical knowledge in far shorter time than the old seven years' apprenticeship. With this greater ability to acquire practical knowledge comes also greater ambition on the part of the apprentice. He does not consider the possibility of remaining an ordinary workman, but aspires to higher positions, such as in time he should be qualified to fill, and it is this phase of the matter which is especially considered by Professor Goss.

"The technical graduate who enters upon a special apprenticeship, by so doing announces that he intends to work for an official position on the road; and the company, in accepting him, agrees so to train him that he may be worthy such a position. In view of this compact, the special apprentice accepts a low wage, and the railroad company undertakes to vary his task, notwithstanding the fact that such a course limits, for a time, the usefulness of the apprentice.

"On a very few large railroad systems the course for special apprenticeships has been worked out with care. Students in such courses are handled with intelligence and consideration, with the result that they are satisfied, while the road accomplishes its full purpose in training men for its service. Most roads, however, undertake to receive special apprentices with no adequate understanding of their responsibility in the matter. It often happens that injustice is done the special apprentice and that in the end the road fails in its efforts to make him a means of strengthening its organization."

Professor Goss compares these condi-

tions, mainly to the disadvantage of the railroad companies, since those who use the special apprentice intelligently appear to be greatly in the minority. If the wages are insufficient to make the apprentice at least self-supporting, the best men will be turned away; and if sufficient opportunity for acquiring valuable information is not given, the whole object of the system, that of producing able men for future service, will be defeated.

"Some roads have fallen into the habit of receiving technical graduates, ranking them as special apprentices, and of then undertaking to see how valuable they can be made to the road, without much regard for the rights of the graduate. By this arrangement it is possible to secure a man for 12 or 14 cents an hour, who can run a lathe, make a drawing, summarize statistics, conduct an experimental investigation, inspect material, report on defective equipment, test a locomotive, figure the bracing for a boiler, outline a scheme for motor-driving in an existing shop, install motors, or interview a division superintendent in behalf of his chief. When a road keeps such a man busy under the hardest sort of conditions, perhaps transferring him to a roundhouse or division shop remote from the center of the road's activity, where he has no contact with men who can aid him and few opportunities to observe processes which can instruct, the attitude of the road toward him is lacking in that element of fairness which is essential to permanent success. An organization in which such things are possible is obviously not ready for a special apprenticeship. It needs more than other roads, perhaps, the technical graduate, but it has no right to accept him as a special apprentice. It ought rather to take its technical graduates as it takes other men, not for the purpose of training them, but for getting service from them, and having them, they should pay them what they earn."

Another defect in the special apprenticeship course, as now generally conducted, is the fact that, during the entire length of the course all the men are paid alike. While at first this is perfectly proper, it prevents all discrimination of merit and effort and may have the disastrous result of killing any attempts of the more ambitious men to do their best, the incentive being altogether too remote to be effective. It is only by a carefully and justly stimulated competition that the best can be brought out, and that the process of sifting out the various degrees of ability can be fully effected.

"Again, underlying the special apprenticeship course as administered upon most railroads is a conception that the technical graduate must be made to overcome as many difficulties as possible. He is set to work with a gang of men unfriendly to his purpose and to him; he is often required to work under a foreman whose chief desire for the time being is to make him show a white feather. He is given the heaviest end of the lever and is required to keep lifting long after the necessity for effort has passed. As a rule, he does not complain, and it usually happens that the men who were factors in making his lot hard are among the first to start a song in his praise. But even though the process seems to work out successfully, it may not be wise. When one's task is made hard merely for the purpose of opposing him there is something wrong. When the same form of opposition is many times repeated, when the apprentice is changed from one gang to another, from shop to roundhouse, and from roundhouse to special investigation, always in the attitude of defense, the process ceases to be disciplinary and uplifting. It tends to dwarf the man rather than to draw him out. Manufacturers, in dealing with the same matter, have learned to handle it in a much more satisfactory way, their plan being to give the technical graduate official recognition from the beginning."

In these matters it appears that the great manufacturing corporations have shown a far greater degree of business discrimination than exists among the railway companies. The various papers which have appeared in recent issues of this Magazine, and that which will appear in the next number, upon the practice of the Baldwin Locomotive Works, show very clearly the extent to which this important matter is understood by the great engineering works of the country, and it is becoming evident that if the railroad companies fail to appreciate their opportunities in this important element of their work they will be avoided by the best

portion of the technically trained men who are seeking opportunities to enter practical work.

The attitude of some establishments is that of conferring a favor upon the student by admitting him to the privilege of working within their sacred limits, and this view has doubtless been the result of the eagerness of young men, in times past, to get into the works. With the development of other lines of work, offering fully as great if not greater ultimate advantages, together with an intelligent comprehension of the proper means of availing themselves of the better grade of ability offered, the railroad shop has placed itself at a disadvantage. Professor Goss has done well in bringing this matter to the attention of the administrators of railway works management, and if they do not see fit to profit by his candid advice, they will have no one to blame but themselves.

THE MANUFACTURE OF CALCIUM CARBIDE.

AN IMPROVED ELECTROLYTIC METHOD OF PRODUCING CALCIUM CARBIDE AT MODERATE TEMPERATURES.

Henri Moissan—Comptes Rendus.

IT has long been recognized that the commercial use of acetylene in the arts, both for purposes of illumination and for heating, as in the recently developed acetylene-oxygen blowpipe, must be largely dependent upon the cost of calcium carbide from which the gas is made. Since the actual amount of electrical energy required for the production of a definite amount of calcium carbide in the electric furnace can be accurately computed, the minimum cost can be determined, and this cost has heretofore been too great to permit of the extensive use of acetylene, its applications being consequently limited. In a communication recently made to the French Academy M. Moissan, whose share in the original development of the carbide and acetylene industries is well known, describes a new method for the production of calcium carbide, which, while a present only a laboratory process, may be capable of development to commercial proportions.

It has already been demonstrated by M. Moissan that in the present method of producing calcium carbide in the electric furnace, the carbon reduces the lime only when the latter has reached the liquid state. This fact necessitates the employment of extremely high temperatures, involving the use of the electric furnace, with its attendant inconveniences and expense. M. Moissan has also shown, however, that metallic calcium will combine with finely divided carbon at a dull red heat, producing pure crystalline calcium carbide. It follows that when calcium is electrolytically produced in the presence of carbon at the temperature of a low red the result will be the formation of carbide. Two methods of applying this principle are described by M. Moissan, both of these having been experimentally demonstrated by him.

The first experiment consists in the use of a graphite crucible for a container and at the same time serving as the positive pole, this being supplied with calcium chloride, into which a vertical negative electrode of carbon is inserted. After the charge has been fused by the passage of an arc the electrolysis is continued by the passage of a current of 10 to 15 amperes at 120 volts. A crust soon forms upon the fused mass, protecting it from the air, while chlorine is freely disengaged and calcium set free, fresh portions of calcium chloride being successively added. The resistance of the bath varies continually, this being probably due to the formation of a subchloride under the varying conditions of the electrolysis. In about an hour the crucible may be broken, when a crystalline mass is found, which, when projected into water, liberates a gaseous mixture of hydrogen and acetylene. Examination shows the mass to consist of calcium and calcium carbide formed from attack upon the electrodes.

The second process is a modification of the first by the addition of about 20 per cent. of calcium fluoride to the chloride. This gives a much more fluid bath which conducts the current very uniformly. Brilliant crystals of calcium form upon the carbon electrode, as may be seen with a

magnifying glass, and these, in contact with water, give off hydrogen mixed with acetylene. By adding to the mixture a certain quantity of petroleum coke in the form of a coarse powder, the electrolysis will proceed as before, but the proportion of carbide will be notably increased. By stirring the fused mass during the operation, in order to bring the carbon into continual contact with the bath, a mass will be produced, which, in contact with water, liberates hydrogen containing from 35 to 59 per cent. of acetylene.

If the direction of the current is reversed the deposit of fused salts containing the calcium and the carbide will be found adhering to the walls of the crucible, and in this case the hydrogen liberated by plunging the mass in water is found to contain as much as 65 per cent. of acetylene. By washing in alcohol the crystals of calcium and of calcium carbide may be separated.

These experiments go to prove that calcium carbide may, under suitable conditions, be produced during a secondary reaction, at a temperature of about 650° C., determined by the thermo-electric couple.

As M. Moissan remarks, these are but laboratory experiments, and their practical application does not immediately appear, but it must be remembered that the early experiments of Willson were originally directed to the production of metallic calcium, and that the resulting calcium carbide was a secondary matter. The electrolytic action in the production of aluminum is a case not greatly different from these recent experiments of Moissan with calcium, and there is reason to believe that a repetition of his investigations upon a large scale may lead to results of commercial importance.

PACKING OF MACHINERY FOR EXPORT.

INFORMATION FOR THE INSTRUCTION OF SHIPPERS OF MACHINERY AND MECHANICAL APPLIANCES TO THE CONTINENT.

Paul Roux—American Chamber of Commerce in Paris.

THOSE who have had the opportunity of observing the various elements which enter into success in export trade in machinery will realize the extent to which careful and intelligent packing affect trade, and for those who have not had this experience the paper of M. Paul Roux, presented before the American Chamber of Commerce in Paris will be of interest and value. M. Roux speaks with the knowledge derived from experience in handling American made machinery in France, and his familiarity with conditions in both countries lend added weight to his words. As he rightly says: the care which is given to packing and preparation for transportation and delivery may not only affect the cost of these operations but may also bear a considerable influence upon the expenses of transportation, custom dues, and storage; and these expenses, in the case of machinery exported from the United States to France, may amount to a considerable percentage of the selling price.

Assuming that a machine has been assembled and inspected in running order, it should in most cases be dismounted and packed in cases representing not more than 2 tons, whenever possible. It must be remembered that for shipping purposes 40 cubic feet are rated as one ton, and unless care is taken in the packing of parts of machines this cubic bulk will be exceeded, to the greatly increased cost of shipment.

Fragile parts should be dismounted for their own protection, even if no reduction in bulk is secured, screw threads being covered with wood or rags and tapped holes closed with wooden plugs. All parts should be most carefully tagged, their positions on the machine being so fully explained that salesmen and others who might not be fully conversant with the machine should be instructed as to their proper places and functions. Finished parts should be protected with a thoroughly efficient coating, and inspection should be made during the packing to ascertain that the coatings are intact after the handling of the packers, otherwise the machine may arrive at its destination almost useless from rust.

"The packing-case must fulfil two requirements: it must effectually protect the machine against all shocks and injury dur-

ing transportation, and must facilitate the handling of the machine—that is to say, that the packing case is at the same time a covering and a vehicle.

"In order to fulfil this double requirement, the case should be specially constructed, and, without fixing general rules, as the details of construction will vary considerably with the forms of different types of machines, the essential requirements will be given for packing-cases containing a machine which is of a weight too great for moving by hand.

"The bottom is the most important part of the case, considered as a vehicle. If this is well designed, it will not only facilitate handling during transportation from the United States to France, and contribute greatly to removing risk of injury, but it is the only part of the case which can be utilised in France if, after remaining in show rooms, it is to be shipped by rail to its final destination. The bottom should therefore be sufficiently strong to carry the total weight of the machine, without the assistance of any other part of the case, when balanced on a roller. It should be constructed with two longitudinal battens, in order that the case may be moved on rollers when cranes are not available, and these battens should be bevelled at the ends to facilitate their employment. Transverse planking, spiked to the battens, forms the bottom of the case. On the bottom, constructed as indicated, two frames should be built around the machine, dividing the length of the case in three parts, in such a manner as to support the pressure of ropes or chains when handling with cranes or other hoisting apparatus. These frames will, at the same time, act as supports for the interior braces, and as lateral supports in case the package is laid on its side, which often happens in spite of instructions. Around these principal elements are built the sides, ends, and top of the case, which are designed simply for protecting the machine generally. In constructing the packing-case, the remarks already made regarding its volume, must be borne in mind. This volume is computed from the over-all dimensions, and often a bolt-head, or a batten, badly placed, will largely increase the cubage.

"In designing the packing-case, it is very necessary to make provision for the examination of the machine in the Custom House, and even for removing it completely. It it absolutely necessary in all events to arrange an opening in one of the sides or in the cover, through which the nature of the machine may readily be seen. This opening should be large enough to permit the examination of all parts of the interior of the case, and to permit the passage of a lantern, if required. It should be closed by a cover secured with screws.

"To allow for removing the machine completely from the packing-case, in order to determine the net weight of the machine for the Custom House, it should be arranged so that the packing and the unpacking may be readily and rapidly accomplished, without it being necessary to injure the panels. For this it is necessary that the top, and one of the sides, be secured with screws, instead of nails, and that the position of the interior battens and braces be indicated externally, in order that the screws and nails fixing them may be readily found."

An important point suggested by M. Roux, and one which is not always considered, is the provision of a list of all detached pieces, together with a drawing, blue print, tracing or engraving showing all accessories which are indispensable to the machine. Such parts as countershafts, keys, wrenches, change gears, etc., must be fully identified as parts of the machine or they may be classed as having to pay a higher duty than the machine itself, and since the machines may be divided into several packages, such a drawing or illustration should be placed in each packing case, since all the cases are not always opened by the customs officers.

Proper marking of the cases is most important, not only for purposes of identification, but also for the use of the customs officers. The exact net weight should be marked on every package, as even a small difference between the marked and the actual weight may cause the imposition of fines. The bulk is the product of the three dimensions over all. In addition to the ordinary marks there should be put on the exterior of each case a list of its contents, this being of especial importance if the cases are to be stored in a warehouse.

In order that a case may be opened with the least delay and without injury to its contents it is recommended that a black circle be painted around the heads of the nails or screws to be removed for unpacking.

These details may seem numerous and unnecessary to many exporters, but they may well be tested by the rule: "Put yourself in his place." The importer has to meet the customs inspectors with prompt answers to all inquiries, or at least with ample facilities for enabling them to make the required inspections. Discrepancies between marks and facts at once arouse suspicion and cause delay, while evidence of good faith and full information must expedite matters which are slow enough even in the most favorable instances. Again, care in packing will generally save far more than its cost in the reduction in breakages, and in the satisfaction which shows itself in repeated orders. If the rules and directions so carefully indicated by M. Roux be examined thoroughly they will be seen to be based on common sense, and to involve very little more trouble and cost than the present slipshod methods of packing which have done so much to discredit machines which in themselves would have been wholly acceptable.

M. Roux has done both American shippers and French importers a service by his timely and valuable paper, which should be studied in full by all who are engaged in sending machinery to any part of the world.

THE FATE OF THE CHAMP DE MARS.

PROPOSITIONS TO IMPAIR OR TO IMPROVE THE GREAT EXPOSITION GROUND OF PARIS FOR THE BENEFIT OF THE PUBLIC.

E Hénard—Le Génie Civil.

FROM time to time reports have appeared in the public prints to the effect that the Champ de Mars, in Paris, the scene of so many triumphs of art and industry in connection with the various international expositions, was to be largely given over to buildings of a permanent nature, and that the remaining vestiges of its former uses were to be entirely removed.

As a matter of fact such a proposition was entertained almost immediately after the close of the exposition of 1900, and the statement was openly made that the maintenance of such an open space was a heavy charge upon the municipality. The plan was then made to turn this historic ground into a real estate speculation, preserving only a limited portion for public gardens. It was hardly to be expected that such a proposition would be permitted to pass unchallenged, and we are glad to notice the energetic protest which has been made by M. E. Hénard, himself a member of the staff of the Universal Exposition of 1900, in the pages of *Le Génie Civil.*

As M. Hénard well remarks, the Champ de Mars has been the Forum of Paris. Originally set apart in 1752 as a parade and exercise ground in connection with the Ecole Militaire, it has been the scene of many notable events in the history of France. Here, on July 14, 1790, the first anniversary of the fall of the Bastille, was held, the Fête de la Federation. Here Napoleon distributed the eagles to the army, and here in 1830, Louis Philippe presented the colors to the National Guard. In 1848 the Fête de la Concorde was held on the Champ de Mars, and it was the scene of various spectacles during the second Empire. Four international expositions have been held upon this site, those of 1867, 1878, 1889 and 1900, each of greater importance and magnificence than its predecessor, while during the intermediate years portions of the grounds have been used for exhibitions of a special nature. During the past forty years large sums of money have been expended in providing means of access to a spot to which such great crowds have been attracted. The avenues Rapp and Bosquet have been cut through, and omnibus, tramway, boat, and railway connections have been multiplied. Stations of the surface and underground railways have been provided, and even as late as the exposition of 1900 the expense incurred i connecting the Ceinture railway with the grounds reached nearly 20 million francs.

At the present time there are on the grounds two structures which were originally erected for the exposition of 1889, and were also used in the exposition of 1900. One of these is the famous Eiffel tower, and the other still bears its original name, the "Galerie des Machines." This latter is undoubtedly one of the finest halls ever constructed, having a clear width of 375 feet and a length of 1,360 feet, there being side wings or aisles 48 feet wide, extending the entire length of the building. The height of the peak of the roof is 160 feet from the ground, and the absence of columns or obstructions of any sort makes the building available for any purpose. Including the galleries across the ends there is a floor area of nearly 19 acres available for civil or military purposes. This fine hall extends across the width of the grounds at the end nearest to the Ecole Militaire, while near the other end rises the Eiffel tower, too well known to need any description here. The area of the Champ de Mars is 44 hectares, or about 109 acres, it thus being the largest open space within the limits of the municipality of Paris, although much smaller than any of the parks in London.

That it should be decided to demolish such noteworthy and useful structures as the Galerie des Machines and the Eiffel tower, and transform this fine breathing space into built-up blocks of houses is indeed to be deplored, and it is to be hoped that even at this late date wiser counsels will prevail and the ground saved.

M. Hénard submits a plan for the utilization of the ground which is illustrated in the article under consideration, and while this may not be wholly acceptable it offers many attractive features. Recognizing the fact that automobilism and aeronautics are among the most conspicuous questions of the day it is proposed to convert the Galerie des Machines into a house for the shelter of dirigible balloons and other machines, the open ground without furnishing an admirable starting place for trial trips and other excursions. The same space is available for an automobile track, and other portions of the grounds may be laid out for football, tennis and other out-door games, while the Eiffel tower will remain to continue its services to meteorology, experimental mechanics and observation, as in the past.

Thus, although it is certain that these grounds will no longer be used for the purposes of international expositions, they may well be preserved for continual usefulness, serving also for the site of special exhibitions, and for the various occasional demands for a place of public meeting. It is certain that Paris is none too well supplied with open spaces within the the limits of the fortifications, and no efforts should be spared to preserve the Champ de Mars from the fate to which it has apparently been devoted.

MAIN-LINE ELECTRIC TRACTION.

AN ESTIMATE OF THE PROBABLE COST OF EQUIPPING THE RAILWAYS OF ENGLAND AND WALES WITH ELECTRIC POWER.

F. F. Bennett—Institution of Electrical Engineers.

IT is difficult to draw accurate conclusions from data which have not been derived from the same line of work as that to which the application is to be made, and sometimes it is not easy to be sure as to the applicability of the results at hand. Thus we have an abundance of information as to the costs and returns of electric and interurban tramways, but when it is sought to apply these to the problem of main-line electric traction it is necessary to be exceedingly cautious. In a paper recently presented before the Institution of Electrical Engineers, Mr. F. F. Bennett examines the question of the electrification of the mail railway lines of England and Wales, deducing, so far as may be, what such an undertaking would cost.

Concerning the relation between the headway of traffic and the commercial success of electric traction, Mr. Bennett does not agree with the general opinion that a close headway is an absolute necessity, although it is naturally a desirable feature.

"The opinion held by the large majority of electrical engineers on railway electrifi-

cation is, that for suburban traffic only is it justified. It has been suggested that the electrification of main or trunk lines might result in a loss to the undertakers, as the load-factor at the power station would be a very poor one owing to the infrequent headway of traffic; but I shall endeavour to show otherwise. On the other hand, the suburban traffic existing in thickly populated areas calls for a more frequent headway and a greater acceleration of speed. This is not only desirable, but is quickly becoming a necessity, if the suburban railway system is to hold its own with municipal tramway competition; and it can be best attained by electrical methods.

"The contention relative to main-line electrification is true if the separate railway companies only considered their own systems, and made electric power provision to meet each individual section of their own lines. If on 50 miles of railway, no matter where located, one power station were placed in the centre to work that section only, it stands to reason that the expenditure for electrification would not be justified. But, if the plant were competent to work the said section 25 miles north and the same distance south of the centre of power, it would also be competent to work all the network of lines within a radius of 25 miles, including even those belonging to other companies."

Taking the railways of England as 15,308 miles, and allowing one power station to every 50 miles, Mr. Bennett computes that there would be required 306 stations, with as many independent superintendents and managers, a state of affairs which would conduce to a reign of chaos, and be prohibitory to any free interchange of traffic. Instead, therefore, he proposes an altogether different plan.

"Assuming that the country could be divided into areas of 900 sq. miles, and a central power station were placed in the centre of each area to supply power to all railways, irrespective of whether they are separate companies or not, within such area. With the object of organising a uniform electrical system common to all companies, I would recommend the formation of a central directing Board consisting of members appointed by the railway companies, one representative for every 500 miles of railway or part thereof. After a period of investigation, this Board could finally select and adopt the system of electrification which they deemed to be the best one to be common to all the companies alike.

"England and Wales contain 58,370 sq. miles; if we average the area required for each power station at 900 sq. miles, the total number of power centres required would be 65. Each railway company could subscribe towards the capital cost of erecting the power centres and sub-stations, in the direct proportion or ratio of their respective train mileage recorded in the complete previous year's working. If the system ultimately adopted should be one of polyphase generation, serving direct current to the trains through sub-stations, I would advocate one such sub-station to every 36 sq. miles, making a total of 25 distributing stations for each power centre. The companies could provide their own equipment such as rolling stock, feeders high and low tension, third rail or trolley wires—in fact, all the plant necessary outside the power stations and sub-stations. The current taken by each company for their purposes could be measured by meter, and the payments due from each individual company could be ascertained and adjusted by the Railway Clearing House.

"To discover the total power required for working one section of 900 sq. miles, it is necessary to calculate the mean weight of each train along with the mean speed. In order to obtain the former, I have made inquiries from several reliable authorities, with the result that 200 tons per passenger train, and 350 tons per goods and mineral train, are safe figures to take. For passenger trains I have based the mean speed upon the time taken by 34 long-distance trains and 15 short-distance trains, taking Manchester as a centre. This I consider to be a fair average speed by passenger trains in England and Wales. The short-distance trains are taken to be within a 15-mile radius of Manchester at an average distance of 7½ miles. The long distance trains are taken to be without the 15-mile radius, at an average distance of 68 miles. There is no certain information to be ascertained as to the mean speed of goods and mineral trains, and for the purposes of this Paper I have taken this speed to be 15 miles an

hour; with this traffic very considerable delays occur, such as shunting at stations to drop and take up waggons, running into sidings to clear for passenger trains, &c."

Mr. Bennett allows 18 passenger trains per day, with a speed of 24 miles per hour and a weight of 200 tons each, also 17 freight trains of 350 tons weight and 15 miles speed, and computes that the power stations, with ample allowance for losses and extra demands, and with complete duplicate plant, should be of 11,000 kilowatt capacity each. The cost of such a station is estimated at £1,416,000, and hence the cost of the total equipment would be a little less than £100,000,000.

Working out the cost of operation, using the data compiled by Mr. Langdon in his paper presented before the Institution of Electrical Engineers in November, 1900, allowing 3½ per cent. interest, Mr. Bennett computes this at a little less than £140,000,000 per annum. Comparing this with the present cost of operation by steam locomotives, it appears that a gain of 0.29 per cent. would follow the introduction of electric traction. In Mr. Bennett's paper these figures are worked out in detail, but the results are certainly sufficient, when the number of assumptions necessarily included are considered.

"Would this extra profit of 0.29 per cent. be a sufficient incentive for the companies to undertake this revolutionary departure? I am inclined to think that it would not, and yet to yield even this small amount of profit it is essential to treat, for purposes of electrification, the railway system as a whole, and in a properly organised way jointly, otherwise I feel pretty confident that the alteration or conversion could only be brought about by incurring a very heavy loss.

"The point now to consider is in what way could electrification be introduced to justify not only this large amount of expenditure, but to benefit the shareholders and all classes of the public alike. It has been proved beyond a doubt that where an accelerated and a more frequent service has been given, along with a generous reduction in fares, the traffic has increased fourfold. In this country and in Italy I believe this to be the case. If this large increase has been obtained with passengers, is it not likely to obtain also with goods and minerals? My opinion is decidedly in the affirmative.

"Now, assume that by gradual steps the railway companies were to reduce the passenger fares to one-half of the mean obtaining to-day—viz., to ½d. per passenger-mile, and the goods and minerals to ¾d. per ton-mile, and to increase the long-distance speed to a mean of 50 miles an hour and the short-distance speed to 30 miles an hour, while at the same time doubling the train-miles by giving a more frequent service. The alteration would lead to an increase of traffic to at least threefold, if not more. The passenger load-factor at present of only 10 per cent. appears to be so ridiculously low that I think with a little differentiation it could be materially improved. It seems absurd to supply a conveyance weighing 200 tons to convey 2½ tons of people about, and that is what it really amounts to. The high peak of the suburban passenger load is when people are going and returning from business, consequently, for 10 or 12 hours out of the 18 the trains are running practically empty. Under these conditions one motor coach and perhaps a trailer would amply suffice during these periods of little traffic, instead of the 200-tons trains in use at the present time; therefore, with double the headway and an accelerated speed a far better passenger load-factor could be obtained. An alteration of this nature would solve many problems, the housing question being one of them. The alteration in the goods and mineral services would lead to the revival of many industries, besides bringing into being many new ones. It would be a boon of incalculable value to the agricultural interest. No longer would it be possible to send fruit and vegetables from the Continent to large Midland towns at lower rate than from our own producing counties; nor would it be probable that finished articles of commerce would be sent from New York via Liverpool to London at a lower rate as from Manchester to London, as the railway freights to London would be less, which is not so at the present time."

Reworking the computation upon the basis of 22 passenger trains per day at a speed of 40 miles per hour, and 20 freight trains at 25 miles per hour, the cost of electrifica-

tion is increased to £150,000,000 and the annual cost of operation to about £22,600,000. This is computed to yield a gain of 1.831 per cent. upon the paid-up capital over that given by steam locomotive traction.

Mr. Bennett warns the railway companies from continuing in their present policy with regard to electrification.

"Indiscriminate installations are useless for proving whether electrification is economical. The only way by which electrical working can be made cheaper than the present method is by adopting one system common for all companies, controlled by one central body like the Railway Clearing House. There are six or seven railway systems in Manchester: would that centre not be a good one to test the system I advocate? Assuming that Manchester and 15 miles round were electrically equipped, the experiment could be made by reducing all the passenger fares to one-half within that radius; and if treble traffic resulted, my theory will have been proved to be correct. The next course to be pursued would be to electrify the whole of Lancashire in the same way, reduce the present fares and freights to one-half within the county, and if the expected results are realised, then the whole of England and Wales could be proceeded with."

THE ARTIFICIAL COOLING OF BUILDINGS.

THE AIR COOLING AND VENTILATING PLANT OF THE MUNICIPAL THEATRE AT COLOGNE ON THE RHINE.

Joseph Musmacher—Gesundheits-Ingenieur.

ALTHOUGH the artificial warming of buildings is one of the oldest of arts the use of mechanical methods of cooling the air in warm weather has been but little applied. Refrigerating machinery has been carried to a high state of perfection, but it has principally been applied to the production of such low temperatures as are necessary for the preservation of meats, and the cooling in breweries, so that the account of the air-cooling plant recently installed in the municipal theatre of Cologne is of especial interest. From a paper by the engineer of the city of Cologne, Herr Joseph Musmacher, published in a recent issue of the *Gesundeits-Ingenieur*, we abstract some account of this work.

Owing to its important position as a railway centre, Cologne receives a large number of foreign visitors during the warm season, and in order that the theatre might remain open during the warm weather it was decided to install such appliances as would insure the maintenance of a temperature not higher than 20° C. (68° F.) in the hottest part of the season. The variations in the external temperature rendered it necessary that the system should be under entire control. The presence of moisture in the air also formed a subject for regulation, so that a number of interrelated questions were involved.

Various methods of maintaining a moderate temperature were examined these including the cooling of the air by spraying finely divided water, or by the circulation of cool spring water through coils of piping arranged in the ventilating passages. Neither of these, however, appeared to offer a wholly satisfactory solution of the problem, and it was finally decided to maintain a circulation of cold brine through piping, using a refrigerating machine to abstract the heat.

Since the building was already completed, and provided with a heating and ventilating plant for winter service, it remained to adapt the cooling system to the passages and communication already in existence. In order that satisfactory results should be obtained it was necessary to provide for the movement of nearly four times as much air in the summer as is required in winter time. The plant was arranged to provide 35 to 40 cubic metres of air per hour per person, while in the summer time the air supply is taken at 130 cubic metres. It is estimated that each person emits 100 calories per hour, and this must be carried off by the cooled air in addition to the maintenance of the difference between 20° C. and the external temperature. Allowing 0.31 calorie for each centigrade degree per cubic metre of air a simple computation shows that the

heat evolved by each person would raise the admitted air by 2.5° C., so that the air should enter the auditorium at a temperature not exceeding 17.5° C. if the limit of 20° C. for the temperature of the auditorium is not to be exceeded. The external atmosphere often reaches a temperature of 26° C., together with a relative humidity of 70 per cent., and the present plant is proportioned to take care of 82,000 cubic metres of air per hour under these conditions. A portion of the cooling is done by the use of coils of pipe through which cold spring water is circulated, and this air is delivered direct to the upper galleries. A part of the air, however, is passed over pipes containing brine which has been cooled to about 5° C., this causing a deposition of the moisture as dew, and thus drying the air as well as cooling it. The water drips from the pipes and is drawn off, and this chilled and dried air is mixed with the remainder of the incoming air in such proportion as to give the required temperature.

The original plan for heating and ventilating the house in winter provided for the admission of the warm air above and the suction of the foul air through openings beneath the seats of the spectators. A similar plan is adopted for the cooling plant, the air being drawn through filter screens by means of disc fans, and delivered to the cooling coils, while the warmed and ventilated air is removed through the ventilating openings in the floor.

In order to avoid the installation of an unnecessarily large refrigerating machine, a so-called "accumulator of cold" is employed, this consisting of a large tank, holding brine which can be cooled by running the refrigerating machine during the day and drawn upon to feed the cooling coils during the evening. The entire details of the installation appear to be very well worked out, and the plant affords an interesting precedent which may serve for the design of similar installations elsewhere.

It is a matter for surprise that artificial cooling has not been developed to a greater extent than at present appears. Thus in many warm countries such installations might prove of great value in connection with theatres, halls, and other places of public assembly. Especially in connection with hospital work, in the treatment of the diseases prevalent during the heated term, it might be practicable to provide the service with a powerful ally in treatment. Instead of resorting to local treatment with ice, the entire hospital could be maintained at any conveniently low temperature, while special rooms could be supplied with chilled, dried and sterilized air in any quantity and under closely regulated conditions.

Such possibilities may well be considered in connection with the great work soon to be undertaken at the Isthmus, and every method and appliance which science can furnish drawn into requisition to aid in the success of that undertaking.

PROGRESS IN AERIAL NAVIGATION.

THE DAWNING OF THE POSSIBLE SOLUTIONS OF THE PROBLEM OF THE MECHANICAL NAVIGATION OF THE AIR.

Octave Chanute—Popular Science Monthly.

ALTHOUGH a great number of attempts have been made to travel through the air by the aid of mechanical appliances, these may all be gathered into two main classes: navigable balloons, and dynamic flying machines. Both of these appear to be approaching some degree of successful solution, and hence the paper of Mr. Octave Chanute, himself a distinguished engineer and experimenter, published in a recent issue of the *Popular Science Monthly*, is timely and interesting.

Mr. Chanute reviews rapidly the progress made by the dirigible balloon during recent years, from the experiments of Giffard to those of Santos, Spencer, Barton, and Stanley. Nearly all the progress which has been made in this line of work has been due to the development of the light and powerful gasoline motor. Giffard, with a balloon 144 feet long and 39 feet in diameter, was able to carry a steam engine of only three horse power, and this motor weighed 462 pounds. The military balloon "La France"

of Renard and Krebs, 165 feet long and 27½ feet in diameter, carried an electric motor of nine horse power weighing 1,174 pounds, but it proved much more manageable than its predecessors, and is was especially well shaped. The gas bag was parabolic in longitudinal section, somewhat like a cigar rolled to a sharp point at both ends, the largest cross section being one-fourth of the distance from the front. The balloon was driven, blunt end foremost, by a screw attached at the front of the car. In the opinion of Mr. Chanute, no better shape and arrangement have yet been devised, and subsequent experimenters who have wandered away therefrom have achieved inferior results, so far as the coefficient of resistance is concerned.

Mr. Chanute refers to the great military balloon of General Meusnier, built by the French government, and having a gas bag of 120,000 cubic feet capacity and a gasoline motor of 45 horse power. Although it is maintained that this powerful machine was never taken out, it is possible that this statement refers to the military trips which it might have taken had war occurred. With the improvements in light motors which have since been made, this balloon could carry a motor of 70 horse power, and probably attain a speed of 30 miles an hour, greater than that of present transatlantic steamers.

The later experiments of Zeppelin, Santos Dumont, Spencer, and others, are well known, and the experiments at the St. Louis exposition will doubtless do much to develop the limitations of this type of machine. Mr. Chanute reports that he has recently found in France a reaction against navigable balloons. It seems to be realized that the speed limit has nearly been reached, at least for the present, and that but small utility is to be expected from the dirigibles. They must be large, costly, and require expensive housing; while they are slow and frail, and carry very small loads. As commercial carriers they are not to be considered, but they may be useful in war and exploration.

Turning to the dynamic machines, Mr. Chanute examines briefly those designs which involve the use of lifting screws, but dismisses them upon the ground that they require relatively an enormous power compared with other machines. The form which appears to present the greatest opportunity for success is that of the aeroplane, in which the motive power is exerted to propel the plane forward, causing it to ride up upon the air. Three important series of experiments have been conducted upon this line, by Maxim, Ader, and Langley, and all three have been unsuccessful because the machines did not possess the required stability. The machine built by Sir Hiram Maxim at a cost of about $100,000, showed that it was capable of lifting itself and its motive power when a forward speed of about 36 miles per hour was attained, but its stability was imperfect and it was broken in the attempt. Similar results followed the trials of the machine built by M. Ader for the French War Department, and by Professor Langley, and all these experiments demonstrated the correctness of the theories with regard to the lifting and supporting power, while at the same time showing that greater stability must be provided together with thorough experience in balancing and managing the apparatus. As Mr. Chanute says, it appears paradoxical that a man shall be expected to acquire experience with a machine before he attempts to use it, but such is the case. The first efforts of a novice in riding a bicycle would lead one to imagine that perfect control of such a machine must be impossible, while the skill of experienced trick riders demonstrates what can be accomplished with practice and experience. There is no doubt that man must go through much the same experience as the young birds, and pass through the awkward stage of flopping about and falling to the ground before he learns to balance himself in the air.

The work of the Wright brothers with gliding aeroplanes has been reviewed more than once in these columns, and it is evident that these experimenters have gone about the task in the proper manner. It was only after three years' practical experimentation that Messrs. Wright felt themselves familiar enough with the manipulation of gliding aeroplanes to venture to add a motor, but from recent reports it appears that they have been successful in propelling their machine by artificial power and in keeping it under satisfactory con-

trol. There appears to be little doubt that the aeroplane problem has been practically solved, but in a manner different from that which has been expected, and the man who desires to use such a machine cannot expect to mount it as he would an automobile and ride off successfully, but rather must devote much time to his personal training as an equilibrist, and qualify himself as an adept. As Mr. Chanute well says:

"Now that an initial success has been achieved with a flying machine, we can discern some of the uses of such apparatus, and also some of its limitations. It doubtless will require some time and a good deal of experimenting, not devoid of danger, to develop the machine to practical utility. Its first application will probably be military. Whe can conceive how useful it might be in surveying a field of battle, or in patrolling mountains and jungles over which ordinary means of conveyance are difficult. In reaching otherwise inaccessible places such as cliffs, in conveying messages, perhaps in carrying life lines to wrecked vessels, the flying machine may prove preferable to existing methods, and it may even carry mails in special cases, but the useful loads carried will be very small. The machines will eventually be fast, they will be used in sport, but they are not to be thought of as commercial carriers. To say nothing of the danger, the sizes must remain small and the passengers few, because the weight will, for the same design, increase as the cube of the dimensions, while the supporting surfaces will only increase as the square. It is true hat when higher speeds become safe it will require fewer square feet of surface to carry a man, and that dimensions will actually decrease, but this will not be enough to carry much greater extraneous loads, such as a store of explosives or big guns to shoot them. The power required will always be great, say something like one horse power to every hundred pounds of weight, and hence fuel can not be carried for long single journeys. The north pole and the interior of Sahara may preserve their secrets a while longer.

"Upon the whole, navigable balloons and flying machines will constitute a great mechanical triumph for man, but they will not materially upset existing conditions as has sometimes been predicted. Their design and performance will doubtless be improved from time to time, and they will probably develop new uses of their own which have not yet been thought of."

AUTOMATIC TELEPHONE EXCHANGES.

ADVANTAGES AND SHORTCOMINGS OF PROPOSED SYSTEMS FOR DISPENSING WITH THE CENTRAL TELEPHONE EXCHANGE.

H. S. Knowlton—American Electrician.

EVER since the introduction of the telephone attempts have been made to devise some satisfactory system by means of which the users might be rendered independent of the central exchange. This is the more interesting because it is generally admitted that the exchange is what has made the telephone the commercial success which it is to-day. The original invention of Professor Bell, ingenious as it was, would have found but a limited application had it been confined to direct communication between two unvarying points, and it was the invention of the exchange which may well be considered as second only to the original device itself. Doubtless much of the effort to displace the central exchange has been due to defective service, but it is a question whether improvement may not better be made in the operation of the central system than by its displacement in favor of any so-called independent system. The entire subject is discussed very intelligently in an article by Mr. Howard S. Knowlton in a recent issue of the *American Electrician.*

In examining this subject it is desirable to understand just what is meant by an automatic system. Properly speaking, an automatic device is one which does not require human intelligence or service for its operation. In telephone parlance, however, it appears to be applied to devices which transfer the work of the central station to the subscriber.

"The automatic system requires the subscriber at least to set up the number which he wants by means of pegs, pins or cranks, and in some cases he is obliged also to ring up the other party to the conversation. These operations are simple enough to persons accustomed to accuracy, but it is another proposition to expect the public at large to grasp the sequence of operations and correctly to manipulate the delicate apparatus of an automatic system each time it talks by telephone. It is true that the annoyances occasioned by operators' mistakes, flippancies and thoughtlessness are eliminated in local traffic by the automatic exchange, but it is possible that other vexations may occur. It is not difficult to imagine the trouble which it would be to a business man in a large city to have to put his mind upon solving the puzzle of setting up numbers himself at some crisis of his affairs when every moment is of great value and every faculty of his mind required to be at its highest efficiency. Here is a chance for the most decided annoyance to enter, and if the private branch exchange be cited as a remedy it only removes the trouble a step further. Perhaps the most important function of the telephone lies in its time-saving qualities, and in the case of a subscriber who wants a large number of numbers in sequence, the inconvenience of setting up all these numbers himself, and probably ringing them up as well, is no imaginary burden."

In order to obtain a correct view of this phase of the question let it be supposed for the sake of argument, that the central exchange had not been devised, but that every subscriber had to attend to the details of making the connection every time he wished to use the instrument. Under such conditions it is not difficult to imagine that the bold innovator who ventured to invent and introduce the central exchange would be hailed with joy as the man who had delivered his fellow men from a great nuisance and enabled them to be served instead of having to wait upon themselves. An excellent example of the way the thing works in actual practice is seen in the extent to which the introduction of private exchanges has been developed. Although a number of offices, close to each other in the same office building may be most suitably arranged to admit the introduction of some mechanical system of making connections it has been found desirable to provide a small sub-exchange so that a cheap attendant may save this trouble and permit each user to have the annoyance of attention to the connection taken off his hands.

There is a growing tendency among the inventors of mechanical recording and accounting devices to make the operation of these depend to some extent upon the joint service of the customer. Thus the automatic cash registers, and fare indicators in street railways, assume that the purchaser or passenger is desirous of aiding the company in keeping tab on his employees, making of him a sort of extra clerk or even spotter, without so much as even asking his permission, and in a variety of ways this game is being worked, the indifference of the public being taken for acquiescence. In the case of the automatic telephone, however, this does not seem to be the case, since the pressure for the use of such instruments does not appear to emanate from the telephone companies, nor from the customers either, for that matter.

"It is doubtful if a great public service system like the telephone exchange can be entirely reduced to machine methods with the ready acquiescence of the public. Human nature is at each end of the line, and conditions are bound to arise where something more intelligent than machinery is needed to straighten matters out. Thus, in a conversation through an automatic central office the transmission may be imperfect and cannot be remedied without the delay of an appeal to the wire chief, whereas it might be possible for an operator in a manual exchange to suggest effective remedies or notify the trouble man at the very moment the difficulty was noticed. No mere machine, however intricate or wonderful, can possess intelligence, and that quality is one of the most vitally important characteristics of an efficient operator. An illustration of the public's attitude toward this is found in the antipathy which was shown to the use of the graphophone to inform a calling subscriber that the line sought was busy. This monotone repetition of the words, 'The line is busy, please ring off!' became so annoying to the public that the telephone companies are lately substituting

other means of imparting this unwelcome information."

So far as practical experience has taught anything in telephone work it has been to show the desirability of relieving the user for everything possible. The mere taking of the receiver from the hook and calling for the desired number appears to have reduced the customer's portion of the work to a minimum, where it is most desirable that it should be retained.

"The whole trend of telephone practice has been toward greater simplicity in the subscriber's station and its operation; witness the replacement of the magneto generator and local battery by the common battery central-energy exchange. The first cost of this has been very high, sometimes a thousand dollars per foot in the central office multiple switchboard alone, but the reduced maintenance charges and increased satisfaction on the part of the subscriber have gone a long way toward justifying the change. It is hard to estimate the betterment of service produced by enabling the subscriber to call the central office simply by removing the receiver from its hook, as compared with the old method of grinding out signals through a sometimes cranky magneto."

Apparently the true way to improve telephone service is along the lines which have thus far proved so satisfactory, by developing the efficiency of the central exchange. It is difficult to see how human intelligence and service can be altogether avoided, but at least it can be reduced to a minimum and taken altogether out of the hands of the subscriber and concentrated among a class of operators especially trained for the worked and skilfully directed by competent supervision. Anything which, under the name of automatic service, transfers any of the detailed drudgery of making the connections to the hands of the subscriber should be regarded in its true light, and given some more fit name than the misnomer which is now attached to it.

THE REGULATION OF THE NILE.

LAKE MOERIS OF THE PHARAOHS AND THE MODERN BARRAGE AND RESERVOIR AND DAM AT ASSOUAN.

Sir William Willcocks—Khedivial Geographical Society.

MUCH has been said and written about the great dams and regulation works which have been constructed upon the Nile, and the interest which attaches to structures of such magnitude and importance is not to be minimised. The work is not completed, however, with the building of the great dam and its auxiliary structures, and many things yet remain to be considered in connection with the control of the great river. In a lecture recently delivered by Sir William Willcocks at Cairo, before the Khedivial Geographical Society, the whole question is fully examined, and some most interesting relation between the modern works and those of the ancient Pharaohs are given, the whole forming a study of the subject which will repay perusal.

In the first place, Sir William Willcocks admits that the Assouan dam, as at present constructed, while doing all that was expected of it, is not doing all that Egypt demands.

"The Assouan reservoir, at its present level, contains one milliard of cubic metres of water, which will suffice for the conversion of half a million acres to perennial irrigation, adding £15,000,000 to the wealth of the country. But though the dam was only completed at the end of 1902, already the whole of the water has been devoted to special tracts, and the government is reluctantly compelled to refuse all applications for water. This has been an unexpected blow to the country, which had been waiting patiently these six years for the long-promised reservoir. While the whole world is crying for that long-stapled cotton which in its highest grades is the specialty of Egypt, the Egyptian landowners of 1½ million acres are compelled to wait perhaps for many years, while every country under the sun which can grow cotton is trying to acclimatize their special product, and they themselves are doomed to sit idle."

Two things need to be done to provide the three milliards of cubic metres of water

which are necessary. The dam at Assouan should be raised 6 metres, an addition for which provision has been made in the original design; and an auxiliary reservoir, a modern lake Moeries must be provided, to enable the additional water to be dealt out as needed.

The location of the reservoir, as Sir William Willcocks unhesitatingly affirms, is in the Wady Rayan, long ago pointed out by Mr. Cope Whitehouse as the proper site. This natural depression is admirably adapted, both by level and situation, for the purpose, being located in the desert to the south of the Fayoum, and separated from it by a limestone ridge. It has, at a level of about 29 metres above the sea, a surface of 700 square kilometres, or about one quarter the area of the ancient lake, which has been closely identified with the present Fayoum. Like the ancient lake, the lowest point of the Wady is 41 metres below sea level. When filled with water the greatest depth will be 70 metres. The uppermost four or five metres will be utilised annually, or some 3 milliards of cubic metres of water out of a total volume of 20 milliards.

"When the Assouan dam will have been raised we shall be standing on the threshold of what it will be able to do. The projected Wady Rayan reservoir, the modern lake Moeris, will be well able to supply the remaining two milliards of cubic metres of water when working in conjunction with the Assouan reservoir. The great weakness of this projected lake has lain in the fact that by itself it can give a plentiful discharge in April and May, less in June, and very little in July. But when the Assouan reservoir is capable of supplying two milliards of cubic metres of water it will be possible to utilise the lake to its utmost capacity. The Assouan reservoir, being high above the level of the Nile, can give its supply at the beginning or end of the summer; it can give it slowly or with a rush; while the projected lake Moeris, being directly in communication with the Nile, and only slightly above low Nile level, its discharge will depend entirely on the difference of level between it and the Nile, and consequently as the summer advanced it would gradually fall and would not be able to give at the end of the summer a quarter of the discharge it could give at the beginning.

"But let us imagine that the reservoir and the lake are both completed and full of water, and that it is the first of April. Lake Moeris will be opened to the Nile, and give all the water needed in that month, while the Assouan reservoir will be maintained at its full level. In May, lake Moeris will give nearly the whole supply and the reservoir will give a little. In June the lake will give little, and the reservoir much; while in July the lake will give practically nothing and the reservoir the whole supply. Working together in this harmonious manner, the reservoir and the lake, which are the true complements of each other, will easily provide the whole of the water needed for Egypt."

The lake can be used as a reservoir holding either two or three milliards of cubic metres of water; and, as projected for the larger quantity of three milliards of cubic metres, it will have a feeder canal from the Nile north of Sharaouna to the edge of the deserts north of the Mazura regulator on the Yusufi canal, and then along the edge of the deserts to the point where the Lake canal begins to traverse the deserts. This canal will be 30 kilometres long and will insure the lake being filled annually to a height of 31 metres above sea level if necessary; although it is estimated that a height of 29 metres above sea level will be sufficient. The 31 metre level will render the canal capable of relieving the Nile of 1,000 cubic metres per second for 50 days, or reducing its flood level by 30 centimetres for that period of time. The main lake canal will traverse the desert opposite Mayana, entering the Wady Rayan at its easternmost point, this forming the outlet from the lake, into the Nile, both canals being provided with the necessary regulators.

Sir William Willcocks gives estimates for the cost of the construction necessary to carry out the plan, showing that for an expenditure of £500,000 on the Assouan dam and £2,000,000 on the lake at Wady Rayan, an increase in the value of the irrigated land of £45,000,000 will result. He gives some interesting historical references, showing that there is great probability that the seizure of the controlling works of the ancient lake Moeris was the true origin of the famine of the days of Joseph, and shows that the relief demanded in modern times

must be conducted along the lines which were found successful in the days of the Pharaohs.

"The great fact before us is the complete disposal, within 12 months, of the first milliard of cubic metres of water stored in the Assouan reservoir, and the eager demand for more from every quarter of the country. If the government had at its disposal to-day the 3 milliards of cubic metres of water which are still required, they would be disposed of within an incredibly short space of time. The area which could be put under cotton every year in the country, provided there was sufficient water available in summer, would be 2½ million acres. This area would insure 10 million cwt. of ginned cotton every year, as against 6 million cwt. to-day. Every acre of reclaimed land in Lower Egypt is specially suited to cotton. Such being the case, and the value of the water being so exceedingly great, and its storage so exceedingly easy, there is no reason why this storage should not be immediately undertaken.

"Four thousand years ago Egypt stood at the parting of the ways, and adopted a system of water storage and flood control suited to basin irrigation which served the country well for thousands of years. To-day Egypt stands again at the parting of the ways, and it may be her destiny to adopt a system of water storage and flood control suited to perennial irrigation which may stand her well for the thousands of years which may yet have to come."

HIGH-SPEED TOOL STEELS.

THE MANUFACTURE AND USE OF MODERN RAPID-CUTTING STEELS FOR USE WITH MACHINE TOOLS.

J. M. Gledhill—Coventry Engineering Society.

ALTHOUGH the use of the modern high-speed tools steels was received with what may almost be termed the cold-shoulder in Great Britain when the results of the work of Messrs. Taylor and White in the United States was first announced, this apparent indifference has now entirely passed away, and efforts are being made to show British engineers the importance and desirability of falling into line in this important development of modern industry. Among the firms which have entered upon the production and exploitation of the modern steels none has been more active and energetic than Messrs. Armstrong, and the results of their work have been well presented in a paper before the Coventry Engineering Society by Mr. J. M. Gledhill.

In the early portion of his paper Mr. Gledhill describes the various processes of making steel, and although this part of his address has no especial bearing upon the so-called high-speed steels, yet some of his remarks are of interest and value in this connection. Thus, the importance of providing the best of material is insisted on.

"It has been proved from long and extensive experience that the finest qualities of crucible steel can only be made by using the best brands of Swedish or Dannemora ores, and which, on account of their freedom from impurities—that is, their low percentages of phosphorus and sulphur—render them the most suitable for producing tool steels that will best retain their cutting edges. High percentages of phosphorus in tool steel (anything above .03% phosphorus would be considered detrimental) is as opposed to good steel as fire is to water. Of course, these Swedish irons are expensive, and the process of converting them into steel is slow and costly, as only comparatively small quantities of steel can be produced compared with the amount of fuel and labour expended. It therefore follows that the best brands of crucible steel must always command a high price, for it is impossible to satisfactorily produce them from inferior materials. You cannot produce good steel from bad materials, nor can you make bad steel into good steel, but conversely you can very easily make good steel into bad if you do not work and treat it properly; and, to sum up on these points, if a good article is to be produced in crucible steel, just as in everything else, good materials must be used and a fair price paid for the article."

"There is no royal road, so to speak, to

the production of high-class tool steel, the first essential being the use of the highest qualities of raw material as a general basis, and together with this, care and skill in its melting and manufacture throughout, and still further where exceptional results are desired, the exercise of scientific research as to the proper compositions for the various tempers of tool steel suited to the specific purposes for which they are required."

Unfortunately Mr. Gledhill gives no details whatever of the composition or method of manufacture of the high-speed steel of Messrs. Armstrong, but this omission is the less important, since Messrs. Taylor and White, both in their patents and in the report of the investigation of their steel by the Franklin Institute, have described fully the composition and method of tempering such steels. Mr. Gledhill, however, gives some useful information as to the forging and preparation of the tools, which may be of interest in connection with the use of any of the modern steels.

"Having obtained the bar, it is necessary to cut off the required lengths; and this must be done at a forging heat. The lengths must not be broken off cold, as this tends to cause cracks in the bars. For forging, the steel should be placed in the fire, and slowly but thoroughly heated, taking care that the heating has penetrated to the centre of the bar, and then forged at a bright red heat. Whilst forging, the bar should not be allowed to get lower than a good red. After the tool is forged it should be laid down in a dry place and allowed to cool slowly. To harden the tool, the nose only, should be gradually, but fairly rapidly, raised to a white melting heat, and then cooled with an air blast. If during this heating the point of the nose becomes fused or melted, no harm whatever has been done.

"After grinding, which should be done on a wet stone, the tool is then ready for use.

"To obtain the maximum efficiency it is essential that the nose of the tool shall be raised to a white melting heat as described.

"Another method which may be described of preparing the tools is as follows:—

"Forge the tool as before, and when cold roughly grind to shape on a dry stone or dry emery wheel. The tool then requires heating to a white heat, just short of melting, and cooling in the air blast. This method also lends itself for cooling the tools in oil; before which the temperature has to be lowered from the white heat to a good red heat (1,600° F.) either by the air blast or in the open, and the tool then quenched out in oil. Tools hardened by the latter method are specially good where the retention of a sharp edge is a desideratum, as in finishing tools, capstan and automatic lathe tools, brass workers' tools, etc."

Mr. Gledhill gives a number of instances of the cutting capacities of high-speed steels, not only for lathe tools, but also for milling cutters and for twist drills, showing beyond doubt the correctness and reliability of the statements which have been for them, and concludes by showing the importance of the subject to the engineering industries of Great Britain.

"It cannot be denied that the question of high-speed cutting is one of national importance to our country, for if we are to remain successful and retain our position in the engineering world, we must not only possess the best and most modern designs of machine tools, but we must also produce the best qualities of tool steel to serve them to their utmost producing capacities, for it matters not how excellent the one may be if the other is a laggard; the one must be the reciprocal of the other as near as practically possible. Given this, we then place ourselves in the most favourable position for the rapid and economical production of our various manufactures, and for best meeting our opponents in the open field of competition. This is why the question is indeed a national one, and it should be our aim to use every effort and skill to develop our machinery and the tool steel in connection with it to their highest states of efficiency. Speaking for high-speed steel we must feel that we are only in the early stages of its manufacture and use, and that nothing approaching finality has been arrived at. When the steel maker looks at the innumerable alloys of whose behaviour and proportions when mixed with steel, so much has yet to be learned, and also to the infinite number of combinations and percentages of those alloys with steel, and the corresponding varied results obtained, it is easily seen what a large field of research there is yet to traverse."

RAILWAY DEVELOPMENTS IN CENTRAL ASIA.

AN EXAMINATION OF COMMERCIAL AND MILITARY TRANSPORT PROBLEMS FROM RUSSIAN AND BRITISH VIEWPOINTS.

Verein Deutscher Ingenieure—Society of Arts.

ABOUT two years ago we reviewed in these columns the development of the Transcaspian railway system of Russia, showing the extent to which it was planned to include connections with the projected Central Asiatic Railway connecting Orenburg in Russia with Tashkent in Turkestan, together with the bearing of these extensions to the trade and political conditions in Afghanistan. We now have further interesting papers upon the same subject, one being an article in the *Zeitschrift des Vereines Deutscher Ingenieure* by Engineer P. Romanow, admittedly prepared from Russian sources upon the development of the Central Railway of Asia, and the other a paper presented before the Society of Arts by Col. Sir Thomas Holdich upon the commercial relations of Great Britain with Afghanistan. Taken together, these important articles give a most interesting view of the progress which is being made in the re-exploitation of a part of the world, old in a historical sense, but new when considered as a field for the development which follows the locomotives and the flags of Europe.

Broadly, the system of railway development adopted by Russia for its territory in central Asia may be examined as two distinct lines. From Batoum, the Russian port at the eastern end of the Black sea, there is railway connection through Caucasia to Baku on the Caspian, this being the outlet for the petroleum of the great Baku district; the port of Baku being also connected with the general railway system of Russia. The so-called military railway in the Transcaspian district starts from Krasnowodsk, directly across the Caspian sea from Baku, and was completed as far as Samarkand as long ago as 1888, this line passing through Merv and Bokhara. Although this line was primarily built for military purposes, it has served to develop commercial importance, Samarkand being a city of 58,000 inhabitants, and an ancient trade centre.

During the past three years this line has been extended to Tashkend, the capital of the province of Syr-Darja, a city of more than 160,000 inhabitants, and from thence a branch has been extended to Andishan, in the centre of the cotton growing district of Turkestan. From Merv a branch railway has been constructed to Kuschk, on the frontier of Afghanistan, while another branch has been projected to Mesched, from Aschabad, a point further back on the line, Mesched being over the Persian frontier. All this system belongs properly to the Transcaspian railway, but to this has been projected the Central Railway of Asia, extending from Orenburg, on the Ural frontier, to Tashkend, this line passing through the provinces of Turgai and Syr-Darja, and connecting the territory beyond the Caspian directly with the main lines of Russia and with the Siberian railway. This road is now under construction, and when completed will have the effect of opening up a most important country.

In addition to this line, which is now rapidly being pushed, it has been planned to construct a connecting line further east, running from Kriwotschekowo, on the line or the Siberian railway, southward to Tashkend, and forming an immense loop close to the western frontier of China.

From the British point of view the most important portion of the system is that already constructed, extending down to Kuschk, on the frontier of Afghanistan. The British railway from India extends northward to Quetta, and has been prolonged to New Chaman, on the southern frontier of Afghanistan, and could readily be carried to Kandahar, were it not for the opposition of the Ameer of Afghanistan to the construction of any railway in his dominions. It is only about 70 miles from New Chaman to Kandahar, and only about 350 miles across to Kuschk, and if the objections of the Ameer to railways could be overcome it might readily be possible to have the all rail route to India completed.

But is it desirable to have the objections

of the Ameer removed? In a general way Sir Thomas Holdich appears to think it would not be objectionable. Commercial considerations are hardly of sufficient importance to warrant this opinion, especially from the British point of view. The Russian government would be most willing to have the benefit of the mail subsidy to aid in operating its military lines, and England would doubtless gain in point of time, but there are other considerations.

Afghanistan has properly been regarded as a buffer between Russia and India, and in order to be a buffer it must be internally independent. While there is at the present time a strong and vigorous ruler in Afghanistan, it is altogether possible that a weak follower might readily yield to the desire of a strong power to betray confidence reposed in him. Apart from political and military objections, however, the idea of railway communication through Afghanistan offers many pleasing probabilities.

As Sir Thomas Holdich says, the country is a most interesting one with a favorable climate. The distance from London via Moscow to the Caspian, and thence by Herat to the Indian frontier is about 4,000 miles, which might be done in ten days, or under pressure in a week, this being a material reduction in time over the 17 to 20 days' steamer time from London to Bombay. Both countries should gain by the through traffic and by the opening up of points now practically inaccessible.

While many objections may be offered against the idea of railway communication with India by way of Russian territory, there is much to be said in its favour. Communication is not necessarily weakness; the Suez canal has shown that in some cases it may mean added strength, and surely with the progress of civilization the idea of strength in isolation cannot be seriously maintained. Possibly the completion of the rail communication may take place at some future date when Afghanistan shall have become wholly a part of the empire, and if it would not be dangerous then it is difficult to see why it should do so now.

THE MANAGEMENT OF RAILWAYS.

METHODS OF ORGANIZATION AND SYSTEMS OF MANAGEMENT OF AMERICAN RAILROAD COMBINATIONS.

A. M. Waitt—Railroad Gazette.

DURING the past decade there has been a development in railroad combinations which has had a distinct effect upon methods of organization and management, and it has become evident that existing systems must be still further modified if the best results are to be attained. In a recent issue of the *Railroad Gazette* we note a paper by Mr. Arthur M. Waitt which treats of this question in the broad and judicial manner which might be expected from an engineer of his experience and judgment, and some abstract of his views will be found suggestive and valuable.

"For many years past, with the slower growth of individual lines and the occasional absorption of a few small connecting roads, it has seemed possible to extend the system of organization in vogue on the principal line to those absorbed, and the general offices have gradually had placed upon them added duties and jurisdiction, until in far too many cases the roads are suffering from the absolute impossibility of those in the more responsible positions in the management being able to handle the work imposed upon them in the manner they had been in the habit of doing with a less extensive field to cover. In the greatly increased territory supervised, it is rarely possible for the general supervising officers to keep in touch with the details of a large system, as was perfectly possible with a single road.

"In some cases presidents, vice-presidents and general managers have endeavored to still carry the old burden of details, with one of three results. Either the system has developed in a one-sided way (the line in which the officer was originally trained) or the road has not developed satisfactorily, and is still lacking in system; or unfortunately the head of the system has paid the penalty of overwork with his life or broken-down health. The history of our American railroads has given many illustrations of

this statement, and it is to be feared that more are to follow."

Mr. Waitt distinguishes clearly between the man of technical ability and the qualities which go to make up a good executive.

"The most successful man for the head of a department is not the man who can put in the most hours at a desk and who can work hard himself, but rather the one who has the faculty of keeping others at work to good purpose, and knows how to so keep in touch with his subordinates as to know what they are doing and to direct their general movements. It is not the general on the field of battle who wields his sword or shoots the most who is the greatest commander, but the one who from some vantage point can overlook the field of battle, note the movements of his regiments, and direct the dispatching of reinforcements to weakened points and plan strategic moves which will confuse and vanquish the enemy, at the same time standing ready in case of extreme urgency to unsheath his sword and go into the thickest of the fight to lead his men to victory."

With the entrance of railroad management into the field of great corporate combinations it must be realized that broader and more enduring methods must be followed, and that the principles of management must be based upon the same foundations as have proved successful in other lines of business.

"In the financial world large and influential corporations aim to so establish themselves that the continued success and stability of principles and methods will not be interfered with by death or continued absence of even the highest officers of the corporation. Similarly should the foundations be laid for our large railroad systems. This means, first, the establishing of a clearly defined and fixed general policy by the directors concerning the aims and future development and improvement of the system. Second, the selection of the best man obtainable to supervise the development of the system. Third, the determining of the best type of organization for producing the results desired. Fourth, the selection of the best men who can be obtained for department heads and subject to the general policy determined upon by the directors and chief executive, to give the department chiefs freedom, each in his own line, to develop the strongest organization and to produce the best results possible.

"It may be said that it is not safe to give such freedom of action; that the men selected may not be safely trusted with so much authority. The answer would be to get only the best, well-tried men obtainable, and then pay them as much as their type of services will command in any market outside of the railroad service. In this way the men selected will be anxious to do their best and to become fixtures with the company, instead of constantly hoping an opportunity will present itself in some other place to get a salary more commensurate with the services required and given. The knowledge of a man's past accomplishments should be reasonable assurance of his future possibilities.

"On this basis build an organization which will be noted for permanency of office and which will make a point of taking in young men of promising character and ability and of educating and developing them in their line of work so that after a period of five, ten or more years the necessity of looking outside for strong men to fill advanced positions will be obviated, by having at home well-trained and efficient men, thoroughly imbued with the fundamental principles on which the progress of the company was founded years before. In this way stability can be assured, strong railroad men educated and the highest type of results obtained. In this country, happily, there can be seen at least one or more examples of the results of over two decades of organized development on these lines, which speaks for itself."

In general, Mr. Waitt believes that the "departmental" plan is the best for large railroad systems, the board of directors themselves handling the financial matters and selecting the best obtainable men to manage the various phases of administration; these executive and administrative officers being ably and promptly supported in all reasonable calls for financial help. The board of directors should be divided into small committees, each with clearly defined relations to the various departments of the administrative work, and holding frequent stated meetings with the department heads.

These heads of departments should be

chosen with especial reference to their ability in their various lines of work and should be given full freedom of action in all matters pertaining to the specific details of their departmental organization, men, methods, and quality of materials used. Such executive officers should have sufficient skilled assistance as to relieve them from routine work, and all men in administrative offices should be paid such salaries as will give the system the pick of the best men in the country.

By having a carefully prepared schedule printed, giving complete definitions of the jurisdictions of the various departments and the authorities and duties of all the officers of the company, each man may be given full freedom of action within those limits and held wholly responsible for the results; continuance in office being known to be dependent upon those results. Such freedom and such responsibility may be regulated by the plan of holding regular monthly meetings of the department chiefs and the chief executive officer for the discussion of all questions of mutual interest and policy, and for the clearing up of difficulties which may have arisen.

Such are the broad outlines which Mr. Waitt suggests, and it will be seen that they are based upon such principles of common sense and business judgment which should commend them, not only to those who are interested in the successful conduct of railway affairs, but in many allied departments of productive work.

MACHINE TOOLS FOR ACCELERATED PRODUCTION

CHANGES IN MACHINE DESIGN AND IN METHODS OF DRIVING AND HANDLING DEMANDED BY THE NEW STEELS.

William Lodge—National Metal Trades Association.

IN mechanical engineering, as in many other lines of industry, it is almost impossible to change any one detail without involving many others in the change. The introduction of the new rapid cutting tool steels has been discussed from various viewpoints, but it cannot be considered by itself alone, since its influence has permeated all departments of work. In a paper presented before the National Metal Trades Association by Mr. William Lodge, and published in the *Iron Age*, some of these changes are examined in an interesting manner.

"There has never been a period in the history of the machine making industry comparing with the present in the matter of acceleration of pace of whole establishments. This has been brought about by the advent of high speed steels. Manufacturing establishments that formely got along reasonably well with the old methods of handling, storing, distributing and succession of the work in course of construction, will find it necessary to make a complete change in order that the various processes may uniformly keep abreast with each other in the rapid movement of the work going through the factory. High class mechanical engineers are necessary in order to lay out suitable stock rooms to receive in their proper proportion all goods that come under the class of merchandise and that are brought ready to go into the machines, such as cap screws, set screws, nuts, bolts, washers, taper pins, name plates, index plates, &c.

"Other means will become necessary for storing castings, both large and small; also the means of taking care of bar stock, covering all the different grades and shapes, such as square and flat cold rolled, square and flat rough stock, &c. They should be arranged in such a manner that even boys or men of light build may readily handle them from the rack to the machines and out again. The stock room man must be in evidence, as must the receiving clerk, the routing official, for routing the work through the establishment and the conveying system for delivering the goods from the yards to the cranes of the shop and for rapid distribution to and from the various machines. Better arrangements must be had for laying out for tools throughout the factories, leaving more space for work around them. In this respect an utter and entire change will be necessary. Standard gauges and measuring instruments of all descriptions must be provided, and duplicate part systems of manufacture, making

it possible for every piece to be made entirely without reference to the piece to which it is assembled must be extended."

Mr. Lodge points out that it is not only necessary to have machine tools properly designed as to strength and speed for the new steels, but that all the operative conditions must be arranged in accordance with the results which it is desired to attain. Many customers are dissatisfied because they are unable to obtain the results in their shops which have been guaranteed by the maker of the tools, while the trouble is not with the tools but with the conditions under which it is attempted to operate them. In such cases no good results can be expected unless the purchaser unites with the maker to secure the benefits which are within his grasp. There are to-day a number of able engineers whose entire business it is to advise as to the rearrangement and administration of workshops in order that the benefits of modern accelerated methods may be fully secured, and if the managers of shops desiring to keep up with the procession are unable themselves to do this work of reorganization, they may well obtain expert advice upon this as upon other questions.

High speed steels will stand up under heavy cuts at high rotative speeds, but that is all that they will do. They will not make lazy workmen industrious, neither will they make weak lathes strong nor light belts pull. They will not put the work into the lathe nor clear the chips away, and they cannot be expected to turn out work rapidly if the proper sizing is to be obtained by the cut-and-try method. To get the results of which they are capable it is necessary to have heavy and strong tools, fully powered and properly equipped with handling facilities. Furthermore they include the services of intelligent and ambitious workmen, remunerated upon some wage system which offers sufficient incentive for them to get out the best that is in them, together with such skilled supervision as will eliminate altogether the necessity for any guess work on the part of the workman regarding the speed or feed to be employed for any piece of work. In other words they form but the initial element in the modern system of accelerated production, a system which means greater returns both to employer and employee, and which, properly managed, places the establishment in which they appear so far ahead of the old time shop that the two are not to be mentioned in the same day.

Although many statements as to the cutting capacity of the new steels have been made public, some of the facts given by Mr. Lodge may be given because of their practical nature. Thus he says:

"I have seen a lathe running 29 hours at 270 feet per minute, reducing bars of steel 3/12 inches in diameter to 3 inches at one cut, sufficiently true to be delivered to the grinding machine, and without regrinding the tool one single time during the entire period. This created a difference in the time of machining this piece from one hour under the old system down to 2½ minutes with the new, and produced a better piece of work. I have seen a tool stand up a solid hour on cast iron running 125 feet per minute and removing scale.

"Ordinary mild steel can be turned all day at 180 feet per minute with ¼ inch feed and ⅛ inch reduction. Cast iron rolls which formerly had never fewer than two, and frequently three cuts, are turned from the rough casting at one cut of 150 feet per minute, with ⅛ inch feed, ½ inch reduction, leaving the work nice enough to go to the grinding machine. In the matter of deep drilling of lathe spindles of 0.50 carbon, that formerly took five hours, we are now finishing the pieces in 30 minutes. The former speed of 40 revolutions per minute, boring a 1 9/16 inch hole, was changed to 400 revolutions per minute, and the feed from 3/1000 per revolution to 6/1000 per revolution."

These are but a few of the figures which might be cited to show the proportion of time saved by the use of the new methods of work, but such results can only be attained by the conjoined action of improved cutting tools, used in improved machines, fully powered, and attended by interested workmen under competent functional supervision. It is worse than useless for a proprietor to buy a new heavy power lathe, for example, together with a few bars of rapid tool steel and expect these to work a revolution in the shop by themselves. These things are but means to an end, and that end can be attained only by the energetic application of skilled effort.

THE STEAM ACCUMULATOR.

THE EQUALIZATION OF EXHAUST STEAM AND ITS UTILIZATION IN THE LOW-PRESSURE STEAM TURBINE.

Ch. Dantin—Le Génie Civil.

THERE are numerous instances in which the economy obtained by high ratios of expansion and the use of a vacuum cannot be obtained in steam machinery without involving losses or inconveniences which more than counterbalance the advantages. Thus in the case of winding engines for mines, or for pumps and other auxiliaries carrying steam nearly full stroke, there is a large amount of energy wasted in the puffs of exhaust steam, and the utilization of this, together with the gain from the vacuum obtainable by its condensation, is most desirable. In an article in a recent issue of *Le Génie Civil*, by M. Dantin, is given an account of the Rateau steam accumulator, by means of which these irregular puffs of exhaust steam may be equalized and the flow of steam thus obtained employed to drive a steam turbine.

The method of equalizing the pressure is that of providing vessels for the exhaust steam to pass through, these vessels containing a mass of heat absorbing material, sufficient to take up the excess heat at the higher pressures and give it out again to re-evaporate the steam which may have been condensed during the cooler portion of the strokes. Engineers are familiar with the manner in which the metal walls of steam cylinders thus act to condense and re-evaporate the steam, and this action, so disadvantageous in the cylinder, has been turned to advantage in connection with the utilization of the exhaust steam.

M. Rateau has designed his accumulator in several forms. One of these consists of a vertical cylindrical vessel, containing a number of trays of cast iron, these trays being made quite heavy, so as to provide sufficient mass for the absorption of the heat. The entering steam varies in temperature according to its varying pressure, and the masses of metal absorb that portion of the heat which is above the mean, and give it out when the temperature falls below the average. When heat is absorbed a portion of the steam is condensed and collects in the trays as water, the pressure being lowered to the average, while this water is re-evaporated and produces steam again to maintain the average pressure during periods of low temperature. In an installation at the Bruay mines (Pas-de-Calais), four such accumulators are in use, containing in all about 40 metric tons of cast iron. In this plant the pressure of exhaust steam from the large winding engines is equalized so that it only varies between 0.15 to 0.25 kilogrammes per square centimetre.

The steam which has passed through the accumulator comes out in what is practically a continuous flow, and is then delivered directly to the low-pressure turbine, which again exhausts into a condenser; and although the average power of the winding engines is only 175 horse power, the turbine produces 300 horse power from the exhaust steam; this being used for driving an electric generator.

Another form of accumulator devised by M. Rateau consists of a tank of water, into which the steam is discharged. The high capacity of water for heat renders it especially well adapted for the purpose, provided means are devised for bringing the steam into intimate contact with the mass. This M. Rateau has accomplished by the use of several internal flues through which the exhaust steam is passed and from which it is discharged into the mass of water.

Here the steam is condensed and thus raises the temperature of the water, the water boiling off into steam having the average temperature and pressure of the exhaust steam delivered to it. The water tank in this case acts in a manner similar to the reservoir of the so-called "fireless locomotive," except that this latter device was charged with hot water from a boiler.

While such devices must always be regarded as methods of making up the deficiencies of the machines to which they are attached, and not to be employed in new designs when better direct applications may be made, they will find numerous occasions for use in existing plants, to the manifest improvement in their economy.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING 281
ELECTRICAL ENGINEERING 288
GAS WORKS ENGINEERING..... 294
INDUSTRIAL ECONOMY 295
MARINE AND NAVAL ENGINEERING..... 296
MECHANICAL ENGINEERING 298
MINING AND METALLURGY..... 307
RAILWAY ENGINEERING 312
STREET AND ELECTRIC RAILWAYS..... 316

CIVIL ENGINEERING

BRIDGES.

Arch.

The Masonry Bridge at Plauen, Saxony. Carl L. Palen. Illustrates and describes a masonry arch bridge which has a span of 295.2 feet. It will cost about $125,000. 2000 w. Eng Rec—March 26, 1904. No. 61733.

Concrete-Arch.

Some Concrete-Arch Bridge Construction on the Illinois Central R. R. Illustrations with brief description of interesting work. 1200 w. Ry & Engng Rev—March 12, 1904. No. 61396.

Drawbridge.

Counterbalanced Draw Span on the Chicago, Milwaukee & St. Paul. Illustrated description of a new structure at Milwaukee, made necessary by the widening of the channel crossed by the present drawbridge. 800 w. R R Gaz—March 11, 1904. No. 61362.

Opening-Bridge Over Barking Creek. Illustrates and describes a bridge on the Barking and Beckton Light Railway. A single-line bridge on the rolling bascule principle, worked by electric power. 1400 w. Engng—March 4, 1904. No. 61410 A.

We supply copies of these articles. See page 315.

Foundations.

Tower Foundations of the Manhattan Bridge Across the East River, New York City. Illustrated detailed description of the construction. 2800 w. Eng Rec—March 12, 1904. No. 61348.

Girders.

The Graphical Calculation of Flange Stresses in Girders and Trusses. Oscar Sanne. Explains a method worked out by the writer. Diagrams. 800 w. Jour W. Soc of Engrs—Feb., 1904. No. 61543 D.

Loading.

Frequency in the Loading of Railway Bridges. Discusses prevailing practice in regard to loading bridges, offering some criticisms. 1400 w. Engr, Lond—Feb. 19, 1904. No. 61155 A.

Long Span.

The Five-Hundred-Foot Channel Span of the Clairton Bridge. An illustrated sketch of a bridge at Clairton, Pa., of more than usual interest. 2500 w. Eng Rec—March 12, 1904. No. 61347.

New York.

Masonry Construction for the Blackwell's Island Bridge. Describes the construction of the piers and anchorages of this bridge, which will be the third, in order of completion across the East River at New York. Illustrated. 3000 w. Eng Rec—March 5, 1904. No. 61243.

The New Bridges Over the East River at New York (Die Neuen, im Bau Begriffenen Brücken über den East River vor New York). Dr. F. Reuleaux. A general description of the Williamsburg, Manhattan and Blackwell's Island bridges, with photographs and bird's-eye view of New York. 2500 w. Glasers Annalen—March 1, 1904. No. 61636 D.

Nova Scotia.

Substructure Work and Erection of the Shubenacadie Bridge. This railway bridge crosses the river five miles from its mouth, where it is subject to very high tides. The conditions are described and an illustrated description of the substructure work given. 4300 w. Eng Rec—March 26, 1904. No. 61739.

Pittsburg.

The Erection of the Monongahela River Bridge, Pittsburg. The present article illustrates and describes the general features, falsework, derricks, and erection of anchor arms. 3800 w. Eng Rec—March 5, 1904. Serial. 1st part. No. 61232.

Plate Girders.

Improvement of a Plate Girder Bridge at Hartford, Conn. Henry Robinson Buck. Read before the Conn. Soc. of Civ. Engrs. Illustrated description of changes made to remedy the dripping of greasy water on the sidewalks below. 1000 w. Eng News—March 24, 1904. No. 61707.

The Plate-Girder Approaches of the Clairton Bridge. Illustrates and describes details of the viaduct approaches of this bridge near Pittsburg. It is designed largely for steel mill traffic. 1800 w. Eng Rec—March 26, 1904. No. 61735.

Reconstruction.

Reconstruction of a Bridge on the Midland Railway Across the River Trent. Frank Horace Frere. Reprinted from Pro. of Inst. of Civ. Engrs. Describes the old bridge, the method of taking down and removal, and the erection of the new bridge, which is built entirely of steel, of lattice girders of the type known as the "Linville truss." Illus. 3000 w. R R Gaz—March 25, 1904. No. 61716.

Reinforced Concrete.

Melan Concrete Steel Bridge at Dayton, Ohio. Illustrates and describes a seven-arch bridge to be built across the Great Miami River. 1600 w. R R Gaz—March 4, 1904. No. 61246.

Renewal.

Renewal of a Bridge Over Rondout Creek on the West Shore Railroad. Illustrated description of a new bridge 1,228 feet long which presents many questions of adjustment to existing conditions, and must be built without interrupting traffic. 800 w. Ry Age—March 18, 1904. No. 61589.

St. Petersburg.

The Troitsky Bridge Over the Neva, St. Petersburg. Briefly reviews the history of the undertaking and gives an illustrated description. 3300 w. Engr, Lond—March 18, 1904. No. 61772 A.

Substructure.

Substructure of Marsh River Bridge. Herbert J. Wild. Illustrated description of the construction of the substructure of a bridge in Maine to replace a wooden bridge on the Knox and Lincoln Ry. 3700 w. Pro Am Soc of Civ Engrs—Feb., 1904. No. 61176 E.

Terminal.

A Proposed Solution of the Brooklyn Bridge Terminal Problem. S. S. Neff. Describes a plan that can be carried out without the purchase of land or very much alteration of the terminal building, and at comparatively small cost. 2800 w. Eng News—March 3, 1904. No. 61225.

Trusses.

Trusses with Three Chords (Dreigurtige Fachwerke). Karl Haberkalt. An examination of a variety of stiffened bridge trusses and suspension girders, with examples of their use. 7500 w. 4 plates. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 20, 1904. No. 61679 D.

We supply copies of these articles. See page 319.

Viaduct.

Connecticut Avenue Bridge, Washington. Illustrations and description of a proposed viaduct to carry this avenue across the valley. The original design has been recently developed in beautiful details by W. J. Douglas. 1500 w. Ry Age—March 18, 1904. No. 61,588.

WATERWAYS AND HARBORS.

Bombay.

The Development of Bombay Harbor. Map, with information as to what is proposed at this place. 1000 w. Engr, Lond—Feb. 19, 1904. No. 61156 A.

Canals.

New York's New Canal System. Col. Thomas W. Symons. A review of the proceedings which led to the bill appropriating over $100,000,000 for canal improvement, with an outline of the work already begun. 2000 w. Marine Rev—March 10, 1904. No. 61386.

The Canalization of the Elbe and the Moldau. Illustrates and describes the system of canalization under construction. 1800 w. Sci Am Sup—March 26, 1904. No. 61722.

The Canal of Jonage. Enrico Bignami. Begins an illustrated description of a private enterprise which has cost $10,000,000. 2000 w. Engr, U S A—March 15, 1904. Serial. 1st part. No. 61459.

The Water Supply for the Danube-Oder Canal (Die Wasserversorgung des Donau-Oder-Kanales). Emil Grohmann. An exhaustive study of the watershed, with tables of the run-off of various districts, together with topographical map and profiles. Two articles. 12000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Feb. 12, 19, 1904. No. 61640 each D.

Canal Traction.

Electricity in Internal Navigation (Die Elektrotechnik in der Binnenschiffahrt). H. Kareis. Discussing the practicability of the commercial application of electric towing to canals. 1500 w. Zeitschr f Elektrotechnik—March 13, 1904. No. 61665 D.

Dams.

Large Rolling Dams (Barrages Mobiles Cylindriques à Grand Portée). René Koechlin. Illustrating and describing the movable dams across the arms of the Main at Schweinfurth, Germany. Each dam is a cylinder of riveted sheet iron, which can be rolled up in time of flood. 2500 w. 1 plate. Génie Civil—Feb. 27, 1904. No. 61624 D.

Roller Dams (Ueber Walzenwehre). K. E. Hilgard. Illustrated description of the rolling movable dams at Schweinfurt-on-the-Main. Two articles. 2500 w. Schweiz Bauzeitung—Feb. 6, 13, 1904. No. 61645 each B.

Dredging.

Dredging at Loch Raven, Baltimore. Alfred M. Quick. Gives an illustrated description of the dredging plant, with an account of the troubles that led to the city doing its own dredging, and report of the amount saved. 2800 w. Eng Rec—March 5, 1904. No. 61235.

Floods.

Flood Damage to the York Haven Power Plant. O. P. Waters. An account of damage caused by the recent ice freshet on the Susquehanna River. 700 w. Eng Rec—March 19, 1904. No. 61472.

Flow.

Mean-Flow Determination (Die Mittlere Abflussmenge). H. Lauda. Discussing graphical and analytical methods of determining the mean discharge of a stream for a given period of time. 3000 w. Oesterr Wochenschr f d Oeff Bandienst—Feb. 27, 1904. No. 61677 D.

Hydraulic Lock.

The Hydraulic Lock on the Trent Canal at Peterborough. Walter J. Francis. Illustrated description of this lock, designed to take the place of ordinary locks where great differences in elevation are found in a comparatively short distance. Claims a saving of time, economy of water and increased capacity. 4500 w. R R Gaz—March 25, 1904. No. 61717.

Levees.

The Improvement of the Portage Levee System. Prof. Leonard S. Smith. Describes the topography of the vicinity, stating what has been done to protect the land from the overflow, the faults of the work, and the improvements needed. Ill. 4500 w. Wis Engr—Feb., 1904. No. 61183 D.

Quay Wall.

Quay Wall at Delfzijl. An illustrated description of a design used in the Netherlands to accommodate vessels at low tide. 1300 w. Engr, Lond—Feb. 19, 1904. No. 61158 A.

Suez.

The Improvement of the Terminal Harbors of the Suez Canal (Die Seehäfen des Suez-Kanales und deren Verbesserungen). Illustrating and describing the new works at Port Said and Suez. 3000 w. Glasers Annalen—Feb. 15, 1904. No. 61-632 D.

Wharf Crane.

Electric Bridge Crane of Ten Tons Capacity (Elektrisch Angetriebener Portal drehkran von 10,000 kg. Tragfähigkeit). Heinrich Rupprecht. Illustrating a powerful crane recently erected in the harbor of Stettin. An electric radial crane is mounted upon a fixed bridge spanning the railway tracks. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 19, 1904. No. 61641 D.

We supply copies of these articles. See page 319.

CONSTRUCTION.

Beams.

Flexure of Long Beams. H. Reissner. A criticism of a paper by Albert E. Guy, with a reply from Mr. Guy. 2000 w. Am Mach—March 10, 1904. No. 61327.

Building Collapse.

Causes of the Darlington Hotel Collapse. Drawings and further notes illustrating the points brought out in the report of H. deB. Parsons. 600 w. Ir Age—March 24, 1904. No. 61576.

Causes of the Darlington Hotel Collapse. Report of H. deB. Parsons, summarizing the causes of the collapse. 1500 w. Ir Age—March 17, 1904. No. 61557.

Collapse of Ten Stories of an Iron and Steel Frame Structure. Illustration, with account of the collapse of the Darlington Hotel, in course of construction on 46th St., New York. 1500 w. Ir Age—March 10, 1904. No. 61256.

Concerning the Fall of the Darlington Building. Editorial on this disaster, outlining the history of the case and commenting upon it. 3300 w. Eng News—March 24, 1904. No. 61709.

The Collapse of the Darlington Apartment House in New York City. A statement of the general circumstances as known, with discussion of the construction work, and the possible causes of the collapse. Ill. 3000 w. Eng News—March 10, 1904. No. 61352.

The Darlington Hotel Collapse in New York City. Description of this disaster, with editorial comment. 3000 w. Eng Rec—March 12, 1904. No. 61351.

Building Construction.

The Erection of the Wall Street Exchange Building, New York. Illustrated description of a steel cage building about 100 feet square and 327 feet high from sidewalk to top of roof beams. 2000 w. Eng Rec—March 5, 1904. No. 61231.

Chimneys.

Chimneys. Charles L. Hubbard. Some points on the determining of the height, form and size of chimneys. 1800 w. Am Elect'n—March, 1904. No. 61210.

Concrete Piles.

Concrete Piling. An illustrated description of the method of utilizing concrete piles in the improvements made at the Washington Barracks. The concrete is rammed into an iron pipe, which is subsequently withdrawn. 600 w. Sci Am—March 26, 1904. No. 61719.

Domes.

Theory of the Spherical Dome with a Homogeneous Surface, and of the Framed Dome; also Notes on the Construction of Masonry and Metal Domes. Irving P. Church. Discussion of E. Schmitt. 2200 w. Pro Am Soc of Civ Engrs—Feb., 1904. No. 61178 E.

Fire Protection.

Baltimore's Conflagration. An illustrated account of the fire that destroyed $85,000,000 worth of property, with opinions of prominent architects. 5200 w. Ins Engng—Feb., 1904. No. 61519 C.

Fireproof Buildings in the Rochester Fire. Explains the conditions existing in the burned district, discussing the damage. About $3,000,000 of property was destroyed. Ills. 1800 w. Eng News—March 10, 1904. No. 61353.

Lessons of the Baltimore Fire. F. W. Fitzpatrick, in *Fireproof*. An interesting account of the strange freaks of the fire, the materials that best withstood the intense heat, and lessons of importance taught by the disaster. 5400 w. Sci Am Sup—March 12, 1904. No. 61374.

Report to the Chief of Engineers, U. S. A., on the Baltimore Fire. John Stephen Sewell. Reports observations made with the view of arriving at some measure of the efficiency of current methods of fireproofing under some tests. 6500 w. Eng News—March 24, 1904. No. 61708.

Standard Regulations for Fire-Proof Buildings. Abstract of the National Board of Fire Underwriters' suggestions to be incorporated in building laws. 4200 w. Eng Rec—March 26, 1904. No. 61741.

Theatre Cut-offs and Fire Protection. Robert Palm. Discusses prevailing conditions and the requirements for proper protection. 2800 w. Ins Engng—Feb., 1904. No. 61520 C.

The Chicago Theatre Fire. Edwin O. Sachs. Gives facts relating to the burning of the Iroquois Theatre. 3200 w. Engng—Feb. 26, 1904. No. 61307 A.

The Lessons of the Rochester Fire. An illustrated article, with map of the burned district and study of the conditions. 2000 w. Ir Age—March 17, 1904. No. 61432.

The Protection of Fireproof Buildings Against Exposure Fires. Editorial review of the Baltimore and Rochester fires, and the lessons taught by them. 1800 w. Eng News—March 17, 1904. No. 61451.

The Report of an Expert. Views of E. C. Shankland of Chicago Concerning Steel Structures in the Baltimore Fire. Ills. 3400 w. Ir Age—March 24, 1904. No. 61574.

Foundations.

Caisson Foundations for a Large Steel-Cage Office Building on Broadway, New York. Describes in detail foundations of 29 caissons carried down to hard pan, and the methods used. Ills. 2200 w. Eng Rec—March 5, 1904. No. 61234.

We supply copies of these articles. See page 319.

Foundations of the Rogers Building, New York. Describes difficult foundation work for a ten-story steel-cage department store at the southeast corner of 14th street and 6th avenue, New York. 1800 w. Eng Rec—March 19, 1904. No. 61473.

Timber Crib Foundations. George B. Francis. Illustrated article describing the construction of timber cribs for different purposes in various parts of the United States. Plates. 4000 w. Jour Ass'n of Engng Socs—Feb., 1904. No. 61776 C.

Pile Drivers.

Improved and Combination Collapsible Pile Drivers for Railroad Work. Illustrated descriptions of various types. 2400 w. Eng Rec—March 19, 1904. No. 61470.

Plastering.

Difficulties and Methods of Plastering in Winter. D. L. Haigh. Considers the causes of trouble and the means of avoiding them. 3000 w. Eng Rec—March 5, 1904. No. 61238.

Roads.

Road Making in Buxton, England. John Hatton. On the making of tarred macadam roads. Ills. 1800 w. Munic Engng—March, 1904. No. 61173 C.

Road Making in Massachusetts. Asa Goddard. Gives the history of the work under the State aid laws, explaining the duties and methods of the commissioners. 1800 w. Automobile—March 12, 1904. Serial. 1st part. No. 61389.

Tunnels.

The Hudson River Tunnel. Gives a résumé of the principal events in the history of the enterprise now approaching completion. The junction between the New Jersey and New York sections was made March 11, 1904. Ills. 1500 w. Sci Am. March 26, 1904. No. 61721.

The Simplon Tunnel (Simplon Tunnel). The twenty-first quarterly report of the progress of the work, showing the tunnel to be about 91 per cent. of the distance through the mountain. 1500 w. Schweiz Bauzeitung—Feb. 13, 1904. No. 61647 B.

The New York and Brooklyn Tunnel for the Rapid Transit Railroad. An illustrated detailed description of the tunnel being constructed to connect the Broadway extension of the New York Rapid Transit Railroad with the Brooklyn Subway, passing under the East River. 2500 w. Eng Rec—March 5, 1904. Serial. 1st part. No. 61242.

See also Railway Engineering, Motive Power and Equipment.

MATERIALS OF CONSTRUCTION.

Cement.

Engineering Problems in Portland Cement Manufacture. S. B. Newberry. Explains the different classes of hydraulic cements and the making of Portland cement. Ills. 2200 w. Wis Engr—Feb., 1904. No. 61182 D.

Plant and Buildings of the Hecla Portland Cement & Coal Co. Illustrated detailed description of the plant at Bay City, Mich. 2500 w. Eng News—March 10, 1904. No. 61356.

Portland Cement. E. Kuichling. Considers its uses in various engineering constructions, reviewing its history and rapid developments. 4000 w. Munic Jour & Engr—March, 1904. Serial. 1st part. No. 61193 C.

The Works of the Egyptian Portland Cement Company. Illustrates and describes the methods used at a new marl cement mill, situated at Fenton, Mich. Gives plan and section, showing the arrangement of the plant. 2000 w. Eng Rec—March 12, 1904. No. 61346.

Concrete.

Concrete in Mining and Metallurgical Engineering. Henry W. Edwards. Information concerning the ingredients and construction of concrete, cost, treatment, uses, &c. Ills. 6500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61572 C.

Effect of Clay on the Strength of Concrete. From *The Stone Trades Journal.* Gives results of tests for the comparative strength of Portland-cement concrete containing various portions of clay. 1000 w. Am Archt—Feb. 27, 1904. No. 61121.

Decayed Stonework.

Treatment of Decayed Stonework. A. H. Church. A memorandum upon the treatment of the decayed stonework of the Chapter House at Westminster. How to arrest the further process of decay. 2700 w. Quarry—March, 1904. No. 61288 A.

Piles.

Strength of Piles. C. S. Bihler. Read before the Pacific Northwest Soc. of Engrs. Gives results of some recent tests concerning the strength of long timber columns. Tabulated results, with explanatory notes. 4500 w. Ry & Engng Rev—March 12, 1904. No. 61397.

Reinforced Concrete.

A Reinforced Concrete Stable. Illustrated description of a stable recently built in New York. 2000 w. Eng Rec—March 19, 1904. No. 61475.

Destruction Test of a Considère Parabolic Girder (Essai à Outrance d'une Poutre Parabolique du Système Considère). Henry Lossier. Results of a test of a 20-metre span with wire-wrapped members, showing the high resistance of the system. 2000 w. Schweiz Bauzeitung—March 12, 1904. No. 61648 B.

We supply copies of these articles. See page 319.

Ferroinclave: A Fireproof Building Material. H. F. Cobb. Gives an illustrated description of this material as made for roofing and other uses, and its manufacture. 3000 w. Jour Ass'n of Engng Socs —Jan., 1904. No. 61529 C.

Reinforced-Concrete Bridge at Soissons (Pont en Beton Armé à Soissons). Full detailed account of three-span arch skew bridge across the Aisne at Soissons, constructed according to the Hennebique system. 3000 w. Plate. Génie Civil—Feb. 13, 1904. No. 61620 D.

Tests of the Adhesion and Initial Stress of Steel in Concrete. Sam. W. Emerson. A summary of results from a series of tests made. 1000 w. Eng News—March 10, 1904. No. 61354.

The Construction and Use of Concrete-Steel Piles in Foundation Work. Illustrated detailed description of the principal forms which have been employed. 4500 w. Eng News—March 10, 1904. No. 61355.

See also Civil Engineering, Bridges.

Timber.

Fungi in Mining Timber. Jules Elsner. An illustrated article, showing the growths that attack timber and discussing means of overcoming the trouble. 900 w. Ir & Coal Trds Rev—March 4, 1904. No. 61-422 A.

Wood Preservation.

The Preservation of Wood from Fire and Decay. Joseph L. Ferrell. Explains a method of impregnating and enameling wood, claiming very satisfactory results. General discussion. 2500 w. Jour W Soc of Engrs—Feb., 1904. No. 61544 D.

MEASUREMENT.

Adjustments.

The Adjustments of the Engineer's Transit and Level. Howard C. Ives. Describes the methods of adjustment. 4000 w. Jour Worcester Poly Inst—March, 1904. No. 61534 C.

Anemometers.

Electricity Anemometry in the Sea Coast Artillery Service. M. C. Sullivan. Describes the methods of determining wind velocities. 700 w. Elec Rev, N. Y. —March 19, 1904. No. 61466.

Curves.

The Surveying of Curves in Irregular Ground (Die Absteckung von Kurven in Coupierten Terrain). Friedrich Lorenz. Comparing various methods of laying out railway curves and their utility under different conditions. 4000 w. Oesterr Wochenschr f d Oeffent Baudiest—Feb. 27, 1904. No. 61678 D.

Wind Pressure.

Experiments Upon the Pressure of Wind at the Eiffel Tower. Emile Guarini. Illustrates and describes the principle of an apparatus used by M. G. Eiffel at the tower bearing his name. 500 w. Sci Am—March 19, 1904. No. 61436.

MUNICIPAL.

London Drainage.

Extension of the London Main Drainage System. An account of added facilities for the disposal of storm water. 1000 w. Engr, Lond—Feb. 26, 1904. No. 61-316 A.

Manholes.

Standardizing of Subway Manhole Construction. Hugh C. Baker, Jr. Illustrated description of a system designed and patented and used, and last year used experimentally by the N. Y. Telephone Co. 700 w. Elec Wld & Engr—March 19, 1904. No. 61482.

Paris.

The Champ de Mars and the Machinery Hall (Le Champ de Mars et la Galerie des Machines). E. Hénard. A protest against the proposition to devote the former exposition ground to building purposes, and a plea for its retention for public uses. 3000 w. Génie Civil—Feb. 27, 1904. No. 61625 D.

Pavements.

Details of Street Pavements in Salt Lake City, Utah. Drawings and extracts from the specifications used for paving First South street. 1000 w. Eng Rec—March 26, 1904. No. 61736.

Wood Pavement on New York Streets. Frederic Arnold Kummer. Gives information concerning the specifications, and reports remarkable durability. Ills. 1700 w. Munic Jour & Eng.—March, 1904. No. 61195 C.

Sewage Disposal.

Design for Septic Tank (Vorschlag einer Faulkammer). H. Schnack. Plans for septic tank and filters for 10,000 liters of sewage in 24 hours by intermittent treatment. 1500 w. 1 plate. Gesundheits-Ingenieur—Jan. 10, 1904. No. 61666 D.

Septic Tank and Broad Irrigation for Sewage Disposal at the Provincial Jail, Victoria, B. C. Brief illustrated description. 500 w. Eng News—March 3, 1904. No. 61221.

The Biological Disposal of Sewage from Isolated Buildings. Prof. Frank Clowes. Deals with the application of the biological method of treatment to the sewage from the new colony established at Horsham. Ills. Also discussion. 11,800 w. Jour Roy Inst of Brit Archts—Feb. 20, 1904. No. 61398 C.

Sewer Joints.

A Sulphur-Sand Composition for Pipe Sewer Joints. Alexander Potter. Reports the writer's use of this material, and

tests made. Also states other advantages, and gives information concerning cost. 1500 w. Eng Rec—March 12, 1904. No. 61350.

Sewers.

A Large Concrete and Brick Storm Sewer in Newark, N. J. Illustrates and describes important sewer work to provide additional capacity for storm water. 1400 w. Eng Rec—March 12, 1904. No. 61349.

Construction of a Joint Trunk Sewer System in the Valleys of the Rahway and Elizabeth Rivers, New Jersey. An illustrated description of an extensive sewer system serving ten municipalities and having a length of over 23 miles. 5200 w. Eng Rec—March 5, 1904. No. 61233.

WATER SUPPLY.

Artesian Wells.

Atlantic City's Artesian Well Supply. Kenneth Allen. An account of improvements completed and projected for increasing the supply. Ills. 800 w. Munic Jour & Engr—March, 1904. No. 61194 C.

Distilling Plant.

Water-Distilling Plant for Egypt. Illustrated description of two exceptionally large plants for erection and service at Suakim, where they will supply pure water for drinking and boiler use. 1200 w. Engr, Lond—March 4, 1904. No. 61419 A.

Filtration.

A Concrete-Steel-Construction Filtration Plant for the New Haven Water Company. An illustrated description of unusually interesting filtration works. A slow sand filter plant. 3600 w. Eng Rec—March 5, 1904. Serial. 1st part. No. 61230.

A Filtration Plant for Harrisburg, Pa. The water supply is taken from the Susquehanna River, and the conditions are described; also the new filtration plant. 1600 w. Eng Rec—March 19, 1904. No. 61471.

Filtration from the Hygienic Standpoint. Dr. E. G. Matson. Remarks on the diseases usually attributed to impure water, and the value of filtration as a remedy. 2700 w. Pro Engrs Soc of W Penn—Dec., 1903. No. 61537 D.

Illustrated Description of Some Filter Plants and Results. Morris Knowles. 8500 w. Pro Engrs Soc of W Penn—Dec., 1903. No. 61539 D.

Open or Covered Filters? Frans Engstrom. Shows how the problem has been solved in Sweden where the climate is much colder, and gives opinions of expert engineers. 1800 w. Pro Engrs Soc of W. Penn—Dec., 1903. No. 61540 D.

High Pressure.

A Proposed High Pressure Water Supply System for Fire Protection in Chicago. Abstract of a report made to the commission appointed to consider the matter. Presents a plan, the main conduit to be a tunnel beneath the bed of the Chicago River with lateral terminals, &c. Ills. 2500 w. Eng News—March 3, 1904. No. 61220.

Gas Power for High-Pressure City Fire Service. J. R. Bibbins. An illustrated article describing conditions in Philadelphia, the high-pressure pumping station and matters related. 6000 w. Cassier's Mag—March, 1904. No. 61579 B.

High-Pressure Water Service for Fire Protection in New York. Slightly condensed report by Nicholas S. Hill, Jr., on proposed service. 2000 w. Eng Rec—March 19, 1904. No. 61476.

Report on Proposed High Pressure Fire Service for Borough of Brooklyn, New York City. I. M. de Verona. Considers the districts where the service should be installed, the relative advantages of fresh and salt water, cost, &c. 4200 w. Eng News—March 24, 1904. No. 61711.

Report on Proposed High Pressure Fire Service for Borough of Manhattan, New York City. Nicholas Hill. Outlines such a service and gives an estimate of cost. 2000 w. Eng News—March 24, 1904. No. 61710.

Irrigation.

An Irrigated Sugar Plantation in the Sandwich Islands. C. H. Kluegel. Describes the Oahu Plantation as a type. All the water is taken from wells and delivered by pumping. 700 w. Eng News—March 17, 1904. No. 61454.

Desert Irrigation in the Far West. L. R. Freeman. Showing the wonderful results brought about by irrigation. Ill. 2500 w. Rev of Revs—March, 1904. No. 61171 C.

Indian Irrigation and Famine. Reviews the report of the Commission appointed to inquire into and report in regard to the extent and benefit of the irrigation works, results as a relief from famine, &c. 2000 w. Engr, Lond—March 11, 1904. No. 61510 A.

Magdeburg.

The Water Supply of Magdeburg (Zur Wasserversorgung Magdeburgs). H. Peters. Describing the provision of a supply of ground water for the city of Magdeburg, Prussia, to replace the polluted supply from the Elbe. 2500 w. Gesundheits-Ingenieur—Feb. 29, 1904. No. 61668 D.

Paris.

The Supply of Potable Water for Paris (Alimentation de Paris en Eau Potable). J. Bergeron. Report upon future possible sources of supply, with map and hydrologic charts, with especial reference to the Orleans valley. 10000 w. 1 plate. Mem

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Soc Ing Civ de France—Jan., 1904. No. 61675 G.

Pipes.

The Strength of Large Pipes (Zur Festigkeit Weiter Rohre). Dr. Philipp Forchheimer. An examination of the forces acting upon pipes of large diameter, including the deformations due to the weight of the pipe and its contents, and the earth pressure as well as the internal pressure. Two articles. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 26, March 4, 1904. No. 61642 each D.

Pumping Station.

Kirtland Street Pumping Station of the Cleveland Water Works. Charles Goffing. Illustrated detailed description of the buildings and their equipment. 3800 w. Eng Rec—March 19, 1904. No. 61467.

The Philadelphia Gas Engine Pumping Station for Fire Service. Illustrated detailed description of this high pressure pumping station. 3800 w. Eng Rec—March 5, 1904. No. 61244.

3,000 Horse-power Gas Engine Pumping Station for High Pressure Service. J. R. Bibbins. An illustrated detailed description of the Philadelphia station, with information relating to it. 2500 w. Engr, U S A—March 15, 1904. Serial. 1st part. No. 61460.

Reservoirs.

A Concrete-Steel Reservoir for East Orange, New Jersey. Gives a description of this reservoir, which is somewhat novel in design, with illustrations of details. 2000 w. Eng Rec—March 26, 1904. No. 61737.

Progress on the Wachusett Dam of the Metropolitan Water Works, Massachusetts. An illustrated article giving information concerning this large dam at Clinton, Mass. 2000 w. Eng Rec—March 5. 1904. No. 61229.

Stream Pollution.

The Allegheny River, a Bacteriological Problem. Dr. W. H. Ingram. Considers the distribution of disease by impure water, especially typhoid fever, and shows this river to be a source of danger. As the conditions cannot be removed a filtering plant is urged. 5500 w. Pro Engrs Soc of W Penn—Dec., 1903. No. 61536 D.

West Riding Rivers. A series of papers dealing with the various phases of the task undertaken by the West Riding Rivers Board. 3500 w. Engng—March 4, 1904. Serial. 1st part. No. 61412 A.

Sweden.

The Water Supply and Sewerage of Swedish Cities (Ueber die Wasserleitungs und Kanalisationsanlagen der Schwedischen Ortschaften). F. W. Hansen. A general review of municipal waterworks and drainage, with table of data for the principal cities. 5000 w. Gesundheits-Ingenieur—Jan. 31, 1904. No. 61667 D.

Thawing.

Experience in Thawing Water Pipes by Electricity. Reports from several places of success in using this method. 1200 w. Eng News—March 17, 1904. No. 61449.

Thawing Frozen Service Pipes by Electricity. An illustrated explanation of the use of electricity for this purpose. 2000 w. Met Work—March 12, 1904. No. 61306.

Typhoid.

I. Typhoid Fever at Watertown, N. Y. Weston E. Fuller. II. An Epidemic of Typhoid Fever in East Minneapolis. Frederic H. Bass. Two papers reporting investigations made to determine the causes of these epidemics. 3000 w. Eng News—March 3, 1904. No. 61224.

Waste.

The Measurement, Consumption and Waste of Water in the Boston Metropolitan District. Extracts from a valuable report by Dexter Brackett, engineer of the distribution department. 3000 w. Eng Rec—March 19, 1904. No. 61474.

The Waste of Water. Gives the results of the Boston investigation showing the waste to be enormous, discussing some of the causes and the remedy. 2000 w. Ir Age—March 24, 1904. No. 61573.

ELECTRICAL ENGINEERING

COMMUNICATION.

Insulation.

"Gutta Gentzsch." Describes an insulating substance intended for use as a substitute for gutta percha in submarine cables. 2000 w. Elec Rev, Lond—Feb. 26, 1904. No. 61299 A.

Printing Telegraph.

The Siemens & Halske Rapid Printing Telegraph (Schnellwirkender Typendruck-Telegraph von Siemens & Halske A. G.). Wilhelm v. Siemens. A fully illustrated account of the improved apparatus capable of transmitting 2,000 characters per minute. 7500 w. Elektrotech Zeitschr—March 10, 1904. No. 61660 B.

The Steljes Printing Telegraph (Der Steljes Ferndrucker). H. Lindow. An improved form of printing telegraph us-

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ing the alternating current. 3000 w. Elektrotech Zeitschr—Feb. 25, 1904. No. 61655 B.

Pupin System.

The Success of Loaded Lines in Telephony. On the applications made of Dr. Pupin's invention, the difficulties met, and success attained. 1100 w. Elec Wld & Engr—March 5, 1904. No. 61332.

Rapid Telegraphy.

A New System of Rapid Telegraphy. Describes the system recently invented by Patrick B. Delany, designed to transmit and receive messages at the rate of 1000 words a minute over distances of 1,000 miles. 900 w. Sci Am—March 26, 1904. No. 61720.

Sight Transmission.

Tele-Electroscopy. From *L'Electra*. An account of the investigations made recently by Adriano Nisco, of Naples. Ill. 1500 w. Aust Min Stand—Feb. 11, 1904. No. 61500 B.

Space Telegraphy.

Improved Receiver for Wireless Telegraphy (Nouveau Récepteur pour la Télégraphie Sans Fil). N. Vasilesco Karpen. A communication to the French Academy describing a form of suspended needle which responds to the passage of electric waves. 1000 w. Comptes Rendus—Feb. 22, 1904. No. 61650 D.

The Transmission of Electric Energy Without Wires. Nikola Tesla. An account of the writer's work and expectations. Ills. 2500 w. Elec Wld & Engr—March 5, 1904. No. 61330.

Space Telephony.

Photo Telephony. Shelford Bidwell. Reviews what has been accomplished in this field, especially recent work of Mr. Ernst Ruhmer. 1200 w. Nature—Feb. 18, 1904. No. 61119 A.

Submarine.

Some Light on the History of the Submarine Telegraph. Baker A. Jamison. An account of the discovery of the insulating properties of gutta percha, and of its successful application to the needs of submarine telegraphy, and the wrong done the discoverer. 2700 w. Sci Am Sup—Feb. 27, 1904. No. 61125.

Submarine Sound Telegraphy. Gives an illustrated description of perfected apparatus for the transmission and reception of bell sound vibrations through water from one vessel to another. 1100 w. Sci Am—Feb. 27, 1904. No. 61122.

Sub-Stations.

The Telephone Substation. Arthur V. Abbott. The present article deals with induction coils and sub-station circuits. Diagrams. 1500 w. Elec Wld & Engr—March 26, 1904. Serial. 1st part. No. 61753.

Telegraphy.

The Progress of Telegraphy During the Past Thirty Years. William Maver, Jr. An interesting review of the progress during the past thirty years. 2200 w. Elec Wld & Engr—March 5, 1904. No. 61337.

Telephony.

A Review of Twenty-five Years of Telephony. Arthur Vaughan Abbott. 2500 w. Elec Wld & Engr—March 5, 1904. No. 61339.

Brighton Municipal Telephones. Illustrating and describing the laying of the underground ducts and the construction and operation of the exchange; with details of the switchboards, and map of the area served. 3400 w. Elec Engr, Lond—March 4, 1904. No. 61404 A.

DISTRIBUTION.

Choking Coils.

Design of Choking Coils for Alternating Current Circuits. Considers the elementary principles and formulae used in this connection, and discusses the design. 2000 w. Elec Engr, Lond—March 11, 1904. No. 61495 A.

Regulating Impedance Coils: Experiments Illustrating the Importance of Some Details in Construction. C. Faraday Proctor. Read before the Newcastle Loc. Soc. of the Inst. of Elec. Engrs. Gives results of experiments in the use of choking coils for regulating currents. 1800 w. Elec Engr, Lond—March 11, 1904. No. 61493 A.

Conduit Work.

The Conduit Work at the New Power House of the Edison Electric Illuminating Company, Boston, Mass. Illustrates and describes the plan of a large system having 96 ducts. 1600 w. Elec Rev, N. Y.—March 5, 1904. No. 61271.

Converters.

The Pulsation of the Continuous Current of Rotary Converters (Die Pulsation des Gleichstromes Rotierender Umformes). R. Elsässer. A graphical analysis of the relations of the continuous and alternating currents in a rotary converter showing the causes of pulsation. Single-phase and polyphase currents are discussed. 6000 w. Elektrotech Zeitschr—March 3, 1904. No. 61656 B.

Distributing Systems.

I. Overhead High-Tension Distributing Systems in Suburban Districts. George H. Lukes. II. Automatic Apparatus for Regulating Generator and Feeder Potentials. E. J. Bechtel. III. Safeguards and Regulations in Operation of Overhead Distributing Systems. W. C. L. Elgin. Three short papers discussed together. 10000 w.

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Trans Am. Inst of Elec Engrs—Jan., 1904. No. 61552 D.

Earth Resistance.

Earth Connections. W. Moon. Gives information of value concerning the resistance of various materials and discusses the placing of earth-plates. 1600 w. Elec Rev, Lond—March 18, 1904. Serial. 1st part. No. 61764 A.

Group-Switches.

The Use of Group-Switches in Large Power Plants. L. B. Stillwell. Information concerning the group-switch as used in the plant of the Manhattan Ry Co., N. Y., given as introductory to a discussion. Diagram. 1300 w. Trans Am Inst of Elec Engrs—Jan., 1904. No. 61549 D.

Insulation.

Rubber Insulation. Some points on means of determining the value of rubber compounds for insulating purposes. 1200 w. R R Gaz—March 18, 1904. No. 61456.

Oil Switches.

Oil-Switches for High Pressures. E. M. Hewlett. Compares the oil-break switch with the air-break switch, as introductory to a discussion. 350 w. Trans Am Inst of Elec Engrs—Jan., 1904. No. 61550 D.

Switchgears.

Types of Direct-Current Low-Tension Switchgears. W. E. Warrilow. Illustrates and describes various types. 2200 w. Elec Engr, Lond—March 11, 1904. Serial. 1st part. No. 61494 A.

Wiring.

Notes on Interior Wiring. Arthur B. Weeks. Suggestions for the wiring of buildings for electric lighting. Ills. 1600 w. Am. Electn—March, 1904. No. 61213.

ELECTRO-CHEMISTRY.

Analysis.

The Electrolytic Analysis of Gold. F. Mollwo Perkin and W. C. Prebble. Describes experimental investigations, giving results. Ill. 2000 w. Elec-Chem & Met—Feb., 1904. No. 61546 E.

Development.

The Development of Industrial Electrochemistry. Dr. E. F. Roeber. Aims to bring out some general principles which have manifested themselves during the development of the electrochemical industries. 4500 w. Elec Wld & Engr—March 5, 1904. No. 61333.

Electric Smelting.

The New Swedish Electric Furnace Plant for the Manufacture of Steel. Frank C. Perkins. Illustrated description of the steel plant at Gysinge, Sweden, where the Kjellen electric furnace is used. 1800 w. Elec, N Y—March 16, 1904. No. 61399.

Electrolysis.

See Mining and Metallurgy, Copper.

Electroplating.

Electroplating Upon Aluminum. Chas. F. Burgess and Carl Hambuechen. Describes an interesting method of applying a coating that sticks. 1200 w. Electro-Chem Ind—March, 1904. No. 61257 C.

Welding.

Notes on Aluminum Welding. Sherard Cowper-Coles. Discussion of this paper which was read before the Faraday Society, Feb. 2, 1904. Ills. 2000 w. Elec-Chem & Met—Feb., 1904. No. 61547 E.

ELECTRO-PHYSICS.

Conductors.

A Résumé of Our Knowledge of the Physical Properties of Current-Bearing Matter. Dr. Paul R. Heyl. Considers the changes in matter produced by electricity, and cases where no such change occurs. A study of conductors and electrolytes. 3800 w. Jour Fr Inst—March, 1904. No. 61179 D.

Dielectrics.

Conductivity of Dielectric Liquids Under the Influence of the Radium Rays and of the Roentgen Rays. M. P. Curie. Paper presented to the Academy of Sciences. A report of researches. 700 w. Sci Am Sup—March 5, 1904. No. 61285.

Electro-Capillarity.

Electro-Capillarity. An experimental study made by C. Christiansen of the movements and changes of a globule of mercury in an electrolyte, and of falling drops of mercury in an electrolyte. 2000 w. Elec Rev, Lond—Feb. 19, 1904. No. 61184 A.

High Frequency.

Suggestions for Producing High-Frequency Currents and Some of Their Phenomena. Edwin F. Northrup and Elliott Woods. An account of what the writers have done with high-frequency apparatus, how they constructed it, and the phenomena observed. Ills. 2700 w. Elec Rev, N Y—March 19, 1904. Serial. 1st part. No. 61464.

Magnets.

The Letter of Peregrinus on the Magnet, 1269. Translation of a letter written in August, 1269, explaining the principle of the magnetic motor. 4400 w. Elec Wld & Engr—March 26, 1904. No. 61752.

Radio-Activity.

A Note on Mineral Containing Radium in the Province of Quebec. J. Obalski. An illustrated description of an ore specimen taken from a white mica mine. 700 w. Eng & Min Jour—March 17, 1904. No. 61446.

We supply copies of these articles. See page 319.

Thorium: A Radioactive Substance with Therapeutical Possibilities. Samuel G. Tracy. From the *Medical Record*. Gives photographs taken with varying degrees of exposure, and much information concerning this substance. Reports its use in treating tuberculosis. 1500 w. Sci Am Sup—March 5, 1904. No. 61284.

A Study of the Radio-Activity of Certain Minerals and Mineral Waters. R. J. Strutt. Read before the Royal Society. Gives results of an examination of certain radio-active materials, explaining method. 2500 w. Nature—March 17, 1904. No. 61759 A.

GENERATING STATIONS.

Alternators.

The Design of Alternators. H. F. Parshall and H. M. Hobart. Sets forth a method of designing founded upon experimental data. Diagrams. 5800 w. Trac & Trans—March, 1904. No. 61319 E.

Boosting.

The Advantages of Boosting. Frank Broadbent. Considers the use of boosters in charging accumulators. 1200 w. Elec Rev, Lond—Feb. 26, 1904. No. 61298 A.

Commutation.

Commutation of Continuous-Current Generators. G. A. Neild and P. E. Banting. Read before the Rugby Engng Soc. Deals only with machines having slot-wound armatures and carbon brushes. 4500 w. Mech Engr—Feb. 27, 1904. No. 61294 A.

Composite Plant.

A Composite Plant at Bloomsburg, Pa. L. S. Levy. Brief illustrated description of a plant utilizing the power of Fishing Creek Falls, and installing a 300 horse-power engine for use in times of low water. 1000 w. Elec Wld & Engr—Feb. 27, 1904. No. 61111.

Costs.

Some Notes on the Cost of Generating Electrical Energy. E. J. Fox. Points connected with cheap production are discussed with the view of showing that very economical results can be obtained. 3000 w. Engr, Lond—Feb. 26, 1904. Serial, 1st part. No. 61318 A.

The Cost of Electricity in Private Plants. Editorial review of paper by R. E. Fox, read before the Cleveland Inst. of Engrs. 1700 w. Engng—March 11, 1904. No. 61505 A.

Dynamos.

On Turbo-Dynamos. Prof. Dr. F. Niethammer. Outlines the electrical and mechanical difficulties which arise in the design of dynamo-electric generators directly connected to steam turbines of 500 to 4000 r. p. m. Ills. 2000 w. Elec Wld & Engr—March 19, 1904. Serial. 1st part. No. 61480.

The Evolution of Dynamo Design. David B. Rushmore. An illustrated article reviewing the early history of dynamo design, and discussing direct-current generators and alternators. 4500 w. Elec Wld & Engr—March 5, 1904. No. 61342.

Exposition Plant.

Service Power Plant of the Louisiana Purchase Exposition. Illustrated description. 5000 w. Elec Wld & Engr—Feb. 27, 1904. No. 61112.

Generating Set.

Enclosed Steam-Engine and Dynamo. Illustrated description of a compact arrangement of enclosed, self-lubricating, compound steam-engine, coupled direct to a continuous-current dynamo for lighting or power purposes. 1000 w. Engng—March 11, 1904. No. 61504 A.

Historic Station.

The First Central Station for Incandescent Lighting. W. J. Hammer. An account of the first installation of the Edison "Jumbo" dynamo in the 3,000-light central station on Holborn Viaduct, London, started on Jan. 12, 1882. 1700 w. Elec Wld & Engr—March 5, 1904. No. 61341.

Hydro-Electric.

Hydro-Electric Installation at Newry. Illustrated description of a plant built to utilize a fall in this river. The current supplies arc and incandescent lights and motors geared to various machines in English manufacturing works. 2000 w. Engng—March 4, 1904. No. 61416 A.

Hydro-Electric Stations of the Alta Italia Company. E. Bignami. A fully illustrated account of the hydro-electric stations supplying current to Turin and the surrounding country. 4000 w. Engineering Magazine—April, 1904. No. 61686 B.

The Kubel Electric Station (Das Elektricitätswerk Kubel). F. Collischon. A fully illustrated account of the plant utilizing the hydraulic power of the Urnäsch, near St. Gall, Switzerland. There is 2,000 h. p. taken from the river and distributed electrically in the neighborhood. Two articles. 7500 w. Elektrotech Zeitschr—Feb. 25, Mar. 3, 1904. No. 61654 each B.

Municipal Plant.

The Electricity Works and Destructor of the Metropolitan Borough of Hackney. Illustrated description of a successful and economical plant. 1500 w. Elec Rev, Lond—March 11, 1904. Serial. 1st part. No. 61496 A.

Parallel Running.

Alternators in Parallel. H. Bohle.

We supply copies of these articles. See page 319.

Read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. A treatise on this subject, discussing the most important problems. Diagrams. 2400 w. Elect'n, Lond—March 4, 1904. Serial. 1st part. No. 61407 A.

Review.

Dynamo Construction in 1903 (Der Elektromaschinenbau im Jahre 1903). Josef Löwy. A review of improvements in continuous and alternating machines during the past year. Serial. Part I. 1800 w. Zeitschr f Elektrotechnik—Feb. 27, 1904. No. 61662 D.

Seattle.

The Seattle Municipal Light and Power Plant. R. E. Heine. Illustrated description of a plant under construction for furnishing light and power at Seattle, Washington. 2200 w. Elec Wld & Engr—Feb. 27, 1904. No. 61109.

Sparking.

What Ailed the Dynamo? D. H. Browne. An amusing account of dynamo troubles and the search for the cause, with editorial. 2500 w. Elec-Chem Ind—March, 1904. No. 61258 C.

Storage Batteries.

The Storage Battery in Small Central Stations. J. M. S. Waring. Read before the Northwestern Elec. Assn. Considers the application to small stations and features common to all central stations. 1500 w. Elec, N. Y.—March 23, 1904. No. 61513.

Zanesville, O.

A Modern Railway, Light and Power Plant. An illustrated account of the reconstruction of the property of the Zanesville Railway, Light and Power Company. Equipped with both steam and water turbines. 1200 w. Elec Rev, N. Y.—March 19, 1904. No. 61463.

LIGHTING.

Development.

Expansion and Changes in Electric Light and Power Systems. Alton D. Adams. Gives statistics and data of interest showing the great increase of capacity. 3000 w. Elec Wld & Engr—March 5, 1904. No. 61338.

Incandescent Lamps.

The Beginnings of the Incandescent Lamp. Thomas A. Edison. A very interesting account of the writer's early work in this field and final success. 1300 w. Elec Wld & Engr—March 5, 1904. No. 61331.

Intensity.

The Relations Between Temperature and Intensity of Light (Ueber den Zusammenhang zwischen Lichtstärke und Temperatur). Hermann Eisler. A review of the experimental researches of Lummer, Kurlbaum and Langley, with curves showing the relation of increase of light with increase in temperature of incandescent bodies. 3500 w. Elecktrotech Zeitschr—March 10, 1904. No. 61659 B.

Mercury Vapor.

The Cooper Hewitt Mercury Vapor Lamp. P. H. Thomas. A lecture before the People's Institute at Cooper Union. An interesting description with brief account of some of the difficulties met with in its development. 2200 w. Elec Rev, N. Y.—March 19, 1904. No. 61465.

Philadelphia.

Electric Lighting in the City of Benjamin Franklin. W. C. L. Eglin. An account of the consolidation and reconstruction of the electrical supply interests with illustrated detailed description of the main generating station and its equipment. 3000 w. Elec Wld & Engr—March 5, 1904. No. 61329.

Photometry.

See Electrical Engineering Measurement.

Review.

A Quarter of a Century of Electric Lighting. Dr. Louis Bell. Some of the reasons for the rapid development of this enterprise and the factors which have produced it. 3000 w. Elec Wld & Engr—March 5, 1904. No. 61334.

MEASUREMENT.

Errors.

The Errors of Instruments. George T. Hanchett. Comments on errors in the types of measuring instruments used in electrical work and their causes. 2700 w. Cent Sta—March, 1904. No. 61391.

Galvanometer.

A Home-Made Sensitive Mirror Galvanometer. John D. Adams. Gives illustrations and directions for the construction of a galvanometer of the mirror or reflecting type. 1500 w. Am Elect'n—March, 1904. No. 61211.

Internal Resistance.

Measurement of Internal Resistance of a Battery by Ohm's Method. J. L. Dickson. Describes an interesting method. 450 w. Elec Wld & Engr—March 19, 1904. No. 61481.

Oscillations.

A New Method of detecting Electrical Oscillations. J. A. Ewing and L. H. Walter. Read before the Royal Society. An account of experimental investigations and a description of instrument. Ill. 1200 w. Elec Rev, N. Y.—March 26, 1904. No. 61731.

Oscillograph.

Some Uses of the Oscillograph. D. K. Morris and J. K. Catterson-Smith. Read at Birmingham Sec. of Inst. of Elec. Engrs. Describes a method of recording the magnetization curves of transformers during working, and other methods of measurement. 1000 w. Electn, Lond—Feb. 19, 1904. No. 61145 A.

Photometry.

The Development of Industrial Photometry. Prof. C. P. Matthews. On the improvements made in these measurements, the causes of errors, and the accuracy, methods and results now possible. 1200 w. Elec Wld & Engr—March 5, 1904. No. 61325.

Rheostats.

Calculation of Motor Starting Rheostats. F. Meurer and A. Simon. Gives the method of Prof. Görges for shunt motors, as given in *Elektrotechnische Zeitschrift*. 500 w. Elec Wld & Engr—March 12, 1904. No. 61382.

Testing.

Factory Testing of Electrical Machinery. E. R. Cross and R. E. Workman. The present number considers the organization, work and equipment of the testing department. Ill. 3000 w. Elec Club Jour—Feb., 1904. Serial. 1st part. No. 61186.

Windings.

Calculation of the Equivalent Ampere-Turns of Windings for Single and Polyphase Currents. C. F. Guilbert. The object is to deduce formulas of simple form for the cases apt to occur. 600 w. Elec Wld & Engr—March 12, 1904. Serial. 1st part. No. 61381.

MOTORS.

Alternating-Current.

The Alternating-Current Series Motor. F. D. Newbury. An explanation of its operation. 1800 w. Elec Club Jour—Feb., 1904. No. 61185.

Hire.

Should Electric Supply Undertakings Advance Motors on Hire or Hire-Purchase Systems? Sidney E. Britton. Read before the Glasgow Loc. Sec. of the Inst. of Elec. Engrs. Discussing both sides of this question, but favoring these systems. 2500 w. Elec Engr, Lond—Feb. 26, 1904. No. 61297 A.

Induction Motors.

Simple Computation Methods for Induction Motors (Einfache Berechnung von Drehstrommotoren) H. M. Hobart. Illustrating a modified form of the Heyland circle diagram. 1800 w. Zeitschr f Elektrotechnik—March 13, 1904. No. 61664 D.

The Application of Induction Motors. Arthur B. Weeks. Illustrates and describes methods of application. 1200 w. Engr, U. S. A.—March 15, 1904. No. 61462.

Machine Driving.

See Mechanical Engineering, Machine Works and Foundries.

Mine Power.

See Mining and Metallurgy, Mining.

Motor Diagrams.

The Circle Diagram Applied to Oversynchronism (Das Kreisdiagramm für Übersynchronismus). Paul Müller. Showing the inapplicability of the circle diagram to induction motors when they are operated above synchronism. 2000 w. Elektrotech Zeitschr—March 3, 1904. No. 61657 B.

Motor Economy.

Small Gas Engines v. Electric Motors. Claims a saving by introducing the electric motors. 1000 w. Elec Rev, Lond—Feb. 26, 1904. No. 61300 A.

Motor Efficiency.

The Efficiency of Railway Motors (Die Motorleistung im Bahnbetrieb). M. Müller. A review of the theory of Zehme upon the influence of heating on the efficiency of motors. 1500 w. Elektrotech Zeitschr—March 10, 1904. No. 61658 B.

Repulsion Motor.

The Theory of the Atkinson Repulsion Motor (Theorie der Atkinson schen Repulsionsmotoren). M. Osnos. An exhaustive analytical and graphical analysis. Two articles, 6000 w. Zeitschr f Elektrotechnik—Feb. 14, 21, 1904. No. 61660 each D.

Single-Phase.

Single-Phase Commutator Motors and Their Regulation. Translation of a paper by Friedrich Eichberg, printed in the *Elektrotechnisch Zeitschrift*. The present number discusses phenomena appertaining to commutator machines. 2500 w. Elec Engr, Lond—Feb. 26, 1904. Serial. 1st part. No. 61296 A.

The Single-Phase Series Motor in Its Relation to Existing Railway Systems. Charles F. Scott. On the advantages of the single-phase system, and the adaptability of the apparatus to the old system. 1700 w. Elec Club Jour—Feb., 1904. No. 61184.

Speed.

The Rated Speed of Electric Motors as Affecting the Type to be Employed. H. M. Hobart. Read before the Inst. of Elec. Engrs. A study of continuous-current and induction motors, giving tabulated data of eleven designs, and conclusions. Ills. 3500 w. Elect'n, Lond—March 11, 1904. No. 61499 A.

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The Rated Speed of Electric Motors as Affecting the Type to be Employed. Abstract of the discussion of paper by H. M. Hobart. 2700 w. Elect'n, Lond—March 18, 1904. No. 61765 A.

Speed Regulation.

Variable Speed Control. Budd Frankenfield. Begins a discussion of methods of controlling the speed of electric motors. 1500 w. Engr, U. S. A.—March 1, 1904. Serial. 1st part. No. 61214.

TRANSMISSION.

California.

The Yreka Light and Power Transmission. Leon M. Hall. An illustrated detailed description of this plant and its equipment. 2500 w. Jour of Elec—March, 1904. No. 61433 C.

Circuits.

Selection of Transmission Circuits. Alton D. Adams. Discusses points to be considered in the determination of the number of circuits that shall make up the line, and the relations of these circuits to each other. 4800 w. St Ry Rev—March 20, 1904. No. 61728 C.

High Pressure.

The 20,000-Volt Power Transmission Plant. A. J. Bloemendal. Illustrated description of plant at Lebring, Austria, in which 3,000 horse-power is transmitted 20 miles. Details of transformers and line are given. 2500 w. Engng—Feb. 26, 1904. No. 61308 A.

Lightning.

Lightning Protection. Ralph Scott. Considers principles involved, and gives brief illustrated descriptions of devices for the protection of telephones, signals and telegraph instruments. 1700 w. Elec, N. Y.—March 9, 1904. No. 61323.

Lines.

Calculation of Transmission Lines. Alton D. Adams. Gives principles and formulæ applying to the design of transmission lines for either continuous or alternating currents, explaining the calculations. 4500 w. Elec Rev, N Y—Feb. 13, 1904. No. 60843.

Switzerland.

The Electric Power and Transmission System of Schaffhausen, Switzerland. Begins an illustrated detailed description of this remarkable hydro-electric plant. 2300 w. Elec Wld & Engr—March 12, 1904. Serial. 1st part. No. 61379.

Transformers.

Predetermination of Transformer Regulation. Emerson G. Reed. Gives an empirical formula by which the inductance of the equivalent choking coil can be computed for a transformer of a particular type; also tabulated data on a line of commercial core-type transformers. 500 w. Elec Wld & Engr—March 12, 1904. No. 61380.

Terminals and Bushings for High-Pressure Transformers. Walter S. Moody. Considers the location and insulation of terminals in coils. Introductory to a discussion. 2000 w. Trans Am Inst of Elec Engrs—Jan., 1904. No. 61551 D.

The Relative Fire-Risk of Oil and Air-Blast Transformers. E. W. Rice, Jr. A short paper to introduce a discussion of this subject. 900 w. Trans Am Inst of Elec Engrs—Jan., 1904. No. 61548 D.

Voltage.

Voltage Regulation in Alternating-Current Systems. H. S. Meyer. Abstract of a paper before the Liverpool Engng. Soc. Aims to give a general review of some of the most important points, without entering upon a detailed consideration of the theoretical side. 3500 w. Elect'n, London—Feb. 19, 1904. Serial. 1st part. No. 61147 A.

GAS WORKS ENGINEERING

Address.

Presidential Address before the Midland Association of Gas Managers, Condensed. George Helps. Discusses the points of interest in the gas industry of England. 15000 w. Gas Wld—Feb. 27, 1904. No. 61295 A.

Air Gas.

The Production and Application of Air Gas (Das Luftgas, seine Herstellung und Verwendung). Dr. Walter Thiem. Describing a process of charging compressed air with hydro-carbon vapor for illuminating purposes. 3000 w. Glasers Annalen —March 15, 1904. No. 61637 D.

Burners.

Maintenance of Incandescent Gas Burners. E. Haase. Read before the Wis. Gas Assn. Gives facts from the writer's experience with report of cost. 1600 w. Am Gas Lgt Jour—March 7, 1904. No. 61264.

Explosions.

Gas Explosions. L. Bairstow and A. D. Alexander. Deals with results obtained by Mr. Grover when determining the effects of the products of combustion on the next explosion. 1300 w. Engng—March 11, 1904. Serial. 1st part. No. 61506 A.

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Gas Flow.

The Motion of Gases in Pipes, and the Use of Gauges to Determine the Delivery. Richard Threlfall. States the hydraulic principles involved and reports careful investigations made of the points involved. Tabulated results. Ill. 4200 w. Inst of Mech Engrs—Feb. 19, 1904. No. 61313 D.

High Pressure.

High Pressure Distribution at St Margrethen. A, Rothenbach. Summary of a paper read before the German Gas Assn. Briefly describes the high-pressure gas distribution supplying the region at the southern end of Lake Constance. Ills. 1200 w. Gas Wld—March 19, 1904. No. 61763 A.

Incandescent.

Installation and Maintenance of Gas-Arc Lamps. T. H. Hintze. A paper before the N. E. Assn. of Gas Engrs., giving experience with an incandescent-mantle burner intended to compete with the electric arc. 1000 w. Am Gas Light Jour—March 7, 1904. No. 61263.

Mains.

The Laying of Mains and Services and the Recording of the Same. John Hellen. Read before the Michigan Gas Assn. Gives a summary of the methods used in Grand Rapids, Mich. 3500 w. Am Gas Lgt Jour—Feb. 29, 1904. No. 61106.

Producer Gas.

Producer Gas. Prof. A. Humboldt-Sexton. Considers the conditions a good producer must fulfill. Ills. 4300 w. Mech Engr—Feb. 27, 1904. Serial. 1st part. No. 61293 A.

Retorts.

A Method of De-scurfing Gas Retorts. Illustrates and describes apparatus, whereby a steam injector is utilized to introduce a mixture of steam and air. 1000 w. Gas Wld—Feb. 20, 1904. No. 61143 A.

Horizontal v. Inclined Retort Installations, with Notes on Coke Conveying. J. G. Newbigging. Read at meeting of the Manchester Dist. Inst. of Gas Engrs. Also discussion. Gives the writer's experience, with information in regard to first cost and maintenance, and all related questions. Ills. 11000 w. Gas Wld—March 12, 1904. No. 61491 A.

I. Inclines at New Bedford. C. H. Gifford. II. Inclines as Used at Lynn, Mass. C. F. Prichard. Ills. Two papers read before the New England Assn. of Gas Engrs. Describes the arrangement of inclined-retort plants and their management. 3800 w. Am Gas Lgt Jour—March 14, 1904. No. 61385.

River Lines.

The Laying of High and Low Pressure (River) Gas Lines. H. C. Morris. Read before the Michigan Gas Assn. Describes the laying of mains under the river, connecting gas works on both sides, at Saginaw, Mich. Ill. 3600 w. Am Gas Lgt Jour—Feb. 29, 1904. No. 61105.

Street Lighting.

The Illumination of Streets. Paul F. Gaehr. Briefly considers the best illumination, and method of testing. 1200 w. Sib Jour of Engng—Feb., 1904. No. 61189 C.

Water Gas.

Notes on Carburetted Water Gas Workings. H. Kendrick. Read before the Manchester Dist. Inst. of Gas Engrs. The paper is closely related to Mr. Newbigging's paper, and contrasts the cost of producing coal gas and carburetted water-gas, giving details of the latter process. 3500 w. Gas Wld—March 12, 1904. No. 61492 A.

INDUSTRIAL ECONOMY

Apprentices.

Apprenticeship Systems of the Allis-Chalmers Company. P. W. Gates. Describing a practical system, adjustable to widely diversified conditions. 2000 w. Engineering Magazine—April, 1904. No. 61683 B.

British Trade.

British Trade and Foreign Competition. T. Good. Aims to give an impartial statement. 2000 w. Cassier's Mag—March, 1904. No. 61583 B.

Chile.

The Industrial Future of Chile in Connection with the Panama Canal. G. Fred. Collins. A fully illustrated description of the country, its resources, development, and engineering opportunities. 3000 w. Engineering Magazine—April, 1904. No. 61682 B.

Coal Industry.

The Magnitude of the Coal Industry. Extracts from an address before the Modern Science Club of Brooklyn, by F. E. Saward. 3000 w. Sci Am Sup—Feb. 27, 1904. No. 61124.

Education.

Lessons in Engineering Education from America. Robert H. Smith. Reviews the paper of Dr. R. M. Walmsley, read be-

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fore the Inst. of Elec. Engrs. 2400 w. Engr, Lond—March 11, 1904. No. 61509 A.

The Northampton Institute. Illustrated detailed description of one of the chief of the polytechnic and technical institutes of England, and account of the work. 9500 w. Engng—Feb. 19, 1904. No. 61149 A.

Exposition.

The Universal Exposition at Saint Louis, 1904 (L'Exposition Universelle de Saint Louis, 1904). Hugues Brussel. With plan of the grounds and numerous views of the buildings. 2500 w. Génie Civil—Feb. 20, 1904. No. 61622 D.

Labor.

High Unit Labor Cost and Its Effect on Prosperity. Thomas D. West. A very just presentation of the labor question and some of the mistakes. 2500 w. Ir Trd Rev—March 17, 1904. No. 61440.

How Should Organized Labor be Dealt With? J. Kirby, Jr. Address before the Philadelphia convention of the Nat. Met. Trds. Assn. Discusses the conditions in various places, and how best to meet them. 3200 w. Ir Age—March 24, 1904. No. 61578.

Miner's Wages.

The Assessment of a Miner's Wages. Discusses the provision in the Coal Mines Regulation Act of England. 2400 w. Engng—March 18, 1904. No. 61768 A.

Railroads.

The Influence of Railroads on Latin-American Stability. Edward P. North. Historical review showing the influence of frequent intercommunication brought about by railroads, and the tendency to develop stable governments. 1500 w. R R Gaz—March 4, 1904. No. 61245.

Wage Methods.

Wage-Paying Methods from the Viewpoint of the Workman. Henry Hess. A graphical comparison of piece-work, bonus, and premium systems. 3500 w. Engineering Magazine—April, 1904. No. 61684 B.

MARINE AND NAVAL ENGINEERING

Armorclads.

Early Armorclads. Major C. Field. An illustrated review of early work in this field. 2700 w. Sci Am—Feb. 27, 1904. No. 61123.

Battleships.

Latest Battleships Mississippi and Idaho. W. F. Sicard. Information concerning two new battleships to be built for the United States. Ills. 2200 w. Marine Rev—March 10, 1904. No. 61387.

New 13,000-Ton Battleships Mississippi and Idaho, Nos. 23 and 24. W. F. Sicard. Compares some of the principal characteristics of these vessels with the Kearsarge and Alabama, and gives a detailed description. 4000 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61782 H.

On the Offensive Powers of Recent Battle-Ships. Sidney Graves Koon. A study and a comparison. 2500 w. Sib Jour of Engng—Feb., 1904. No. 61188 C.

Cargo Steamers.

Possibilities of Design in Cargo Steamers. George Nicol. Considers ways in which the first cost of vessels may be reduced, and the advantages gained by care in the design of these steamers. 2000 w. Cassier's Mag—March, 1904. No. 61581 B.

Cruisers.

New Cruisers for the Japanese Navy. Information relative to two ships built for the Argentine Republic, but recently sold to Japan, and their official trials. Ill. 2800 w. Marine Engng—March, 1904. No. 61276 C.

Official Trial and Description of the Imperial Ottoman Cruiser Medjidia. Illustrated. 1800 w. Marine Engng—March, 1904. No. 61278 C.

The U. S. S. Denver. Com. W. H. Naumann. Illustrations, general description, and report of official trial. 8800 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61784 H.

The U. S. S. Tacoma. Lieut. U. T. Holmes. General description, with report of official trial. 9000 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61781 H.

U. S. S. Des Moines. Lieut. Walter Ball. General description, with report of official trial. 2300 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61789 H.

Ferryboat.

New Canadian Screw Ferryboat. Illustration, plans, and brief description of a vessel under construction for service at Vancouver. 350 w. Naut Gaz—March 10, 1904. No. 61322.

Train Ferry Boat "Prince Christian" (Eisenbahn-Dampffähre "Prins Christian"). W. Kaemmerer. Illustrated description of new passenger train ferry boat for the railway service between Warnemünde, in Germany, and Gjedser, in Denmark. 1500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Feb. 20, 1904. No. 61603 D.

We supply copies of these articles. See page 319.

Fleets.

A Comparison of the Russian and Japanese Fleets (Vergleich der Russischen und Japanischen Seestreitkräfte). A tabulated comparison of the respective fighting strengths at the beginning of the war. 3000 w. Schiffbau—Feb. 24, 1904. No. 61681 D.

Japanese Works.

The Mitsu Bishi Dockyard and Engine Works, Nagasaki, Japan. Illustrated description of these recently improved works, showing their capacity. 1500 w. Marine Engng—March, 1904. No. 61-277 C.

Launches.

The C. F. Herreshoff Speed Launch. Illustrates and describes a handsome launch on exhibition in New York. 600 w. Automobile—Feb. 27, 1904. No. 61107.

The Development of the High-Speed Launch or Automobile Boat. Shows two new motor-boat hulls designed by Mr. Sutphin Sutphin, and reviews the recent boats that have been built in the United States. 1700 w. Sci Am—March 12, 1904. No. 61371.

The Launch "Moguntia" of the Mainzer Rudder-Verein. Illustrated description of a fast German launch built of galvanized mild steel. 900 w. Sci Am Sup—March 5, 1904. No. 61286.

Lighterage.

Lighterage; Its Advantages and Disadvantages to the Port of New York. A. J. Grymes. An interesting illustrated description of the service, with lengthy discussion. 17600 w. N Y R R Club—Feb. 19, 1904. No. 61523.

Liner.

New Australian Liner Nikko-Maru. Illustrated detailed description of vessel built in Japan. 1800 w. Marine Engng—March, 1904. No. 61279 C.

Naval Machinery.

Improvement in the Installation and Fitting of Naval Machinery. Lieut. H. C. Dinger. A consideration of some of the lines along which improvements are to develop. 7800 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61785 H.

Naval Strength.

The World's Naval Strength. Alfred Smith. A review of British naval strength as compared with other powers. 3500 w. Cassier's Mag—March, 1904. No. 61-584 B.

Paddles.

The Construction of Buckets of Feathering Paddle Wheels (Beitrag zur Konstruktion von Radschaufeln für Räder mit Beweglichen Schaufeln). W. Thele. Deriving a geometrical method for laying out the proper bucket shapes. 1500 w. Schiffbau—Feb. 10, 1904. No. 61680 D.

Petrol Motors.

See Mechanical Engineering. Internal-Combustion Motors.

Propellers.

On the Influence of Inward and Outward-Rotating Propellers on the Manœuvering Quality of Twin-Screw Vessels. Translated from *Mitteilungen aus dem Gebiete des Seewesens*, by Rear Admiral C. R. Roelker. 3700 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61786 H.

San Francisco.

Ship Yards and Shipping of San Francisco. An illustrated review of the shipbuilding yards, with illustrations of some of the vessels. 2300 w. Marine Rev—March 17, 1904. No. 61477.

Ship Telegraph.

A New System for the Electric Operation of Dial Indicators (Ein neues System zur Elektrischen Uebertragung von Zeigerstellungen). W. Thiermann. An improved device for transmitting orders from the bridge or conning-tower of a ship to the engine room. 1800 w. Glasers Annalen—March 15, 1904. No. 61638 D.

Steamers.

New Steamer "Likelike." Illustrated description of a freight and passenger vessel designed for Hawaiian Inter-Island Trade. 600 w. Naut Gaz—March 24, 1904. No. 61599.

S. S. Mongolia—Pacific Mail Steamship Company. L. D. Lovekin. A description of the largest ship yet completed in America, with report of trial. 3900 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61790 H.

Submarines.

Report of the Army Board as to the Usefulness of the Lake Type of Submarine Boat for Coast Defense. A summary of the military view of the usefulness of the submarine designed by Simon Lake. 2000 w. Sci Am—March 12, 1904. No. 61369.

Torpedo Boats.

U. S. T. B. Tingey. Rear-Admiral John D. Ford. General description with report of contract trial. 4500 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61783 H.

Tow Boats.

Design for Twin-Screw Tow Boats. Drawings and description of a light-draught steel tow boat for use on western rivers. 1000 w. Marine Rev—March 10, 1904. No. 61388.

We supply copies of these articles. See page 319.

MECHANICAL ENGINEERING

AUTOMOBILES.

Albany.

The Albany "Silent Safety" Petrol Car. Illustrated detailed description. 2800 w. Auto Jour—Feb. 20, 1904. No. 61142 A.

Ariel.

The Ariel Petrol Cars. Illustrates and describes the characteristic features. 1200 w. Auto Jour—Feb. 27, 1904. No. 61291 A.

Army Automobiles.

The United States Army General Utility and Repair Automobile. Illustration, with detailed description. 600 w. Sci Am Sup—March 26, 1904. No. 61724.

Belsize.

The 16-20-H. P. 3-Cylinder Belsize Car. Illustrated description of a car of English construction. 800 w. Auto Jour—March 19, 1904. No. 61758 A.

Carburation.

Carburetters and Carburation. F. Strickland. Discusses the requirements of a carburetter. 1700 w. Autocar—Feb. 20, 1904. No. 61163 A.

Commercial Vehicles.

Commercial Vehicles Practically Considered. Hiram Percy Maxim. Read before the Auto. Club of America. A discussion of the present state of the art of construction and details of cost of operation. 2000 w. Automobile—March 26, 1904. Serial. 1st part. No. 61742.

Coronet Cars.

The Coronet Cars. Illustrated description of a new English-built car. 1300 w. Autocar—March 19, 1904. No. 61754 A.

Daimler.

The 1904 Daimler Petrol Cars. Illustrated detailed description of this new design, calling attention to the noticeable changes. 1800 w. Auto Jour—March 5, 1904. No. 61401 A.

De Dion-Bouton.

The Latest De Dion-Bouton Petrol Car. An illustrated detailed description of a 10 h. p. car made by this Paris firm. 3400 w. Auto Jour—March 19, 1904. Serial. 1st part. No. 61756 A.

Engines.

The New 12 H. P. James and Browne. Illustrates and describes some of the details of the engine design. 1000 w. Autocar—Feb. 27, 1904. No. 61289 A.

Exhibition.

The Crystal Palace Exhibition. An illustrated article calling attention to novel features in the exhibits, and describing interesting vehicles. 9800 w. Auto Jour—Feb. 27, 1904. No. 61290 A.

The Crystal Palace Exhibition. Illustrations, with descriptions of interesting exhibits. 6000 w. Auto Jour—Feb. 20, 1904. No. 61140 A.

The International Automobile Exposition at Paris. Lucien Perissé. A general account of the exposition of December, 1903, with illustrated description of the leading mechanical features and special types exhibited. 4500 w. Engineering Magazine—April, 1904. No. 61687 B.

French Trials.

French Fuel Consumption and Reliability Trials. Report of these trials, giving tabulated results and illustrations. 1500 w. Auto Jour—March 12, 1904. No. 61488 A.

Gardner-Serpollet.

The 1904 Gardner-Serpollet Cars. Illustrates and describes the 9 h. p. car called the "Simplex," remarkable for its simple construction, economy in fuel, and ease with which it may be driven. 900 w. Autocar—March 12, 1904. No. 61483 A.

Gobron-Brillie.

The 25 h. p. Gobron-Brillie Petrol Car (1904 Type). Illustrated detailed description. 1000 w. Auto Jour—March 12, 1904. No. 61485 A.

Ignition.

An Improved High Tension Ignition. Illustrates and describes an invention, making use of a discovery by Sir Oliver Lodge, which makes the ignition much less sensitive to external or internal causes of derangement. 600 w. Autocar—March 12, 1904. No. 61484 A.

Lubrication.

Gasoline Engine Lubrication. A. E. Potter. Causes of heating and sticking and of excessive oil in cylinders are considered; also best forms of design and proper qualities and quantities of oil. 1700 w. Automobile—March 26, 1904. No. 61743.

Mercedes.

The 1904 Mercedes Models. Illustrations with descriptions of two new cars. 800 w. Auto Jour—Feb. 20, 1904. No. 61141 A.

Motor Bicycles.

Desirable Improvements on Motor Bicycles. Merwyn O'Gorman. From a paper read before the Auto. Club of Gt. Britain & Ireland. Suggestions for increasing speed, fuel efficiency, noiselessness, &c., are discussed. 2000 w. Auto-

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mobile—March 12, 1904. Serial. 1st part. No. 61390.

Motor Wagon.

A Turbo-Electric Wagon. Illustrated description of a novel design propelled by means of a steam turbine and electric motors. 1300 w. Mech Engr—Feb. 20, 1904. No. 61138 A.

Pedrail.

A Walking Locomotive. Illustrations of the pedrail, with description as given by Prof. Hele-Shaw, and remarks. 1800 w. U S Cons Rept—March, 1904. No. 61514 D.

Racing.

How to Tune Up a Racing Automobile. Joseph Tracy. Gives practical suggestions for the guidance of entrants in races who drive medium or high-powered cars. 2500 w. Automobile—March 5, 1904. Serial. 1st part. No. 61321.

Ryknield.

The Ryknield Petrol Cars. English cars which show new features are illustrated and described. 2000 w. Auto Jour—March 5, 1904. No. 61402 A.

Talbot Cars.

The Talbot Petrol Vehicles. Illustrates their 8 h. p. standard tonneau, and the engines on the 20 h. p., the 11 h. p., and the 8 h. p. vehicles, with remarks. 700 w. Auto Jour—March 19, 1904. No. 61757 A.

Thornycroft.

The 20 h. p. Thornycroft Petrol Car (1904 Model). Explains the alterations that have been made, giving an illustrated description of one of the latest cars. 1300 w. Auto Jour—March 5, 1904. No. 61403 A.

Tires.

Motor Car Tires and Springs. J. S. V. Bickford. Discusses the weaknesses of these parts, favoring solid tires, and double elliptical springs, suitably proportioned to the load. Ill. 2500 w. Engr, Lond—Feb. 26, 1904. No. 61314 A.

Tyre Manipulation Illustrated. A series of illustrations showing the most approved methods of detaching and replacing a pneumatic tyre. 500 w. Autocar—March 19, 1904. No. 61755 A.

Trials.

The Progress of Automobilism in 1903 (Les Progrès de l'Automobilisme en 1903). F. Drouin. A review of the principal trials and races of the year. Two articles. 3000 w. Génie Civil—Feb. 13, 20, 1904. No. 61621 each D.

HEATING AND COOLING.

Central System.

Heating from a Central Station. W. H. Pearce. An illustrated article showing that with proper appliances and experience, heating from a central station is a success, and pointing out the cause of loss in the various methods. Also discussion. 14400 w. Jour W Soc of Engrs—Feb., 1904. No. 61542 D.

Central Station Heating. W. H. Schott. Read before the Northeastern Elec. Assn. Discusses when hot-water systems may be used, and when steam would serve better, and the requirements and how to meet them. Shows the importance of automatic regulation. 3000 w. Dom Engng—Feb. 25, 1904. No. 61101 C.

Heat Losses.

To Figure Heating Work Accurately. With a Table Showing the Losses in British Thermal Units for Various Surfaces. Charles F. Hauss. Read at N. Y. meeting of the Am. Soc. of Heat. & Ven. Engrs. Explains the use of the table given. 1000 w. Dom Engng—Feb. 25, 1904. No. 61102 C.

Refrigeration.

A Modern Closed Type Ice Making Plant. Illustrated detailed description of the Peoples Pure Ice Co.'s plant, Chicago, for distilled-water ice manufacturing. 3500 w. Ice & Refrig—March, 1904. No. 61272 C.

Theatre.

The Cooling Plant of the New Municipal Theatre at Cologne (Die Luftkühlanlage für das Neue Stadttheater in Köln a. Rh.). Joseph Musmacher. A full account of the plant for supplying artificially cooled air in summer time. The temperature of the theatre is maintained at 20° C. 3000 w. 1 plate. Gesundheits-Ingenieur—March 10, 1904. No. 61669 D.

Ventilating and Heating the Franklin Square Theatre, Worcester, Mass. Gives plan and description of an interesting plant, having features that are somewhat unusual. 1200 w. Eng Rec—March 26, 1904. No. 61738.

HYDRAULICS.

Elevators.

The Elevators of the Central London Railway (Ascenseurs du Central London Railway). Illustrated description of the hydraulic lifts at the Shepherd's Bush station. 2000 w. 1 plate. Génie Civil—Feb. 20, 1904. No. 61623 D.

Jets.

The Contraction of Jets. Prof. John Goodman. Gives results of an investigation made to obtain a rational coefficient of contraction for a jet issuing from a plain circular orifice. 1200 w. Engng—March 11, 1904. No. 61508 A.

Pumping.

Pumping Machinery for the New Dock at Chatham. Gives illustrations showing

the general arrangements of the plant, which is provided with both centrifugal and suction pumps. These are described in detail. 1200 w. Engng—Feb. 26, 1904. No. 61309 A.

Pumping Engine.

Compound Cornish Cycle Pumping Engine. Illustrated description of a very large pumping-engine at the Waihi Mines, in New Zealand. 1000 w. Engng—March 18, 1904. No. 61770 A.

See Civil Engineering, Water Supply.

Safety Devices.

Safety Devices for Hydraulic Plants. Frank B. Kleinhans. Describes devices to prevent breakages of pipes and cylinders, and other injuries. 1100 w. Eng News—March 3, 1904. No. 61228.

INTERNAL-COMBUSTION MOTORS.

Blowing Engine.

Gas-Driven Blowing Engine with Sliding Air-Valves. Two-page plate, with brief description. 300 w. Engng—March 4, 1904. No. 61414 A.

Fuel Gas.

A Process for the Conversion of Fuels into Heating and Power Gas (Ein Verfahren zur Umsetzung der Brennstoffe in Heiz oder Kraftgas). H. Jahns. Describing a form of series gas producer at the Von der Heydt mines near Saarbruck. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 27, 1904. No. 61611 D.

Furnace Gas.

The Blast Furnace as the Sole Source of Power in a Modern Steel Works. Abstract of an article by Carl Gruber, translated from *Stahl und Eisen*. Describes an imaginary plant. 2600 w. Ir Age—March 17, 1904. No. 61431.

The Purification of Furnace and Producer Gas (Die Gicht und Generatorgas Reinigung). E. Theisen. A description of a form of centrifugal apparatus for removing dust and grit from furnace gases used in gas engines. 3500 w. Stahl u Eisen—March 1, 1904. No. 61672 D.

Gas Engines.

Some Notes on Gas Engines. H. Diederichs. Discusses interesting tests and treatises that have appeared in recent German literature, giving also facts from the writer's own observations. 3000 w. Sib Jour of Engng—Feb., 1904. No. 61187 C.

Gasoline Motor.

The Tygard Reciprocating-Cylinder Double-Action Gasoline Motor. Illustrated description of a motor exhibited at the recent automobile show. 1000 w. Sci Am—March 12, 1904. No. 61370.

Gas Pumping Engines.

See Civil Engineering, Water Supply.

Marine Motors.

Petrol Motors for Marine Purposes. Remarks on the growing use of these motors, the leading forms, and reliability, with information from a paper by Orlando Sumner before the Inst. of Marine Engrs. (England). 1500 w. Engng—Feb. 26, 1904. No. 61311 A.

The Mietz & Weiss Two-Cylinder Marine Kerosene Engine. Illustrated detailed description. 1400 w. Am Ship—March 24, 1904. No. 61595.

Petrol Engine.

A Peculiar Petrol Engine—The "Daniel." Brief illustrated description of an engine in which elliptical cams replace the cranks on the main shaft, and in which no connecting rods are employed. 1100 w. Auto Jour—March 12, 1904. No. 61486 A.

Valves.

Valves and Valve Mechanism of Internal Combustion Engines. Robert E. Phillips. Excerpt from a paper read at the Auto. Club. Considers only engines of the "Otto" or four-cycle type. Ills. 4000 w. Auto Jour—March 12, 1904. No. 61487 A.

See also Mechanical Engineering, Automobiles.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

The "Fatal Blue Heat" in Boiler Making. From *Motive Power*. Explains the meaning of this term by experiment, and the results following the appearance. 600 w. Am Mach—March 17, 1904. No. 61427.

Boring-Machines.

Foreign and American Types of Electrically-Operated Horizontal Boring-Machines. Frank C. Perkins. Illustrated detailed descriptions. 800 w. Sci Am Sup—March 5, 1904. No. 61283.

Castings.

Casting Iron Around Steel. E. H. Powell. Gives directions for this class of work. 1100 w. Foundry—March, 1904. No. 61166.

Defects in Cast Iron, Their Causes and Remedies. Herbert E. Field. Read before the New England Found. Assn. Considers shrinkage and its causes, prevention, &c., blow holes, cracks, cold shuts, weakness, dirt, and hardness. 5700 w. Ir Trd Rev—March 17, 1904. No. 61441.

Direct-Metal and Cupola-Metal Iron Castings. Thomas D. West. Remarks on observations while handling direct metal for foundry purposes. 400 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61564.

Preparing Castings for Machine Work. Frank B. Kleinhans. Describes pickling, putting through the foundry mill, grinding,

and chipping. 1500 w. Foundry—March, 1904. No. 61169.

Specifications for Cast-Iron and Finished Castings. Richard Moldenke. Remarks on the research work of foundry men and the results. 700 w. Trans Am Inst of Min Engrs—March, 1904. No. 61563.

Specifications for Pig-Iron and Iron Castings. Robert Job. Gives the method used by the Philadelphia & Reading Railway Co., with remarks. 600 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61565.

Cupolas.

Fan Power for the Cupola. Thomas D. West. Read before the Pittsburg Found. Assn. Discusses the need of a more definite basis for purchasing the necessary power to run foundry fans. Also considers blast pressure gauges, and blast volume. 3000 w. Ir Trd Rev—March 10, 1904. No. 61324.

Design.

Notes on Design. C. F. Blake. The present article considers machinery shafting. 1200 w. Mach, N. Y.—March, 1904. Serial. 1st part. No. 61203 C.

Dies.

A New Die Head. Illustrated detailed description, with details in regard to the making. 2000 w. Engr, Lond—Feb. 26, 1904. No. 61317 A.

Forging Dies. Thomas Beasley. Illustrates and describes dies for "pin ends," for "head rods," and for eye bolts. 800 w. Am Mach—March 10, 1904. No. 61328.

Electric Power.

Electric Power in Workshops. J. T. Irwin. Read before the Rugby Engng. Soc. Discusses points that should be taken into consideration in planning the equipment. 2500 w. Prac Engr—March 4, 1904. No. 61400 A.

Electric Power in British Shipyards. C. S. Vesey Brown. Begins a review of electric power installations, with special reference to the north-east coast, illustrating applications made and the machines. The first of two articles. 3300 w. Cassier's Mag—March, 1904. No. 61580 B.

Some Uses of Electricity in the Working of Metals. C. F. Burgess. Points out various electrical properties which have been utilized. 2000 w. Wis Engr—Feb., 1904. No. 61181 D.

Emery Wheels.

The Manufacture of Emery Wheels. Waldon Fawcett. Describes the different processes used in making emery and corundum wheels. Ills. 1200 w. Sci Am Sup—March 12, 1904. No. 61372.

Factory Buildings.

The Planning of Factory Buildings and the Influence of Design on Their Productive Capacity. Hugo Diemer. Suggestions aiming to secure utility and economy, and with a view to future expansion. 3000 w. Eng News—March 24, 1904. No. 61712.

Factory Location.

The Economic Theory of Factory Location. Hugo Diemer. Discusses the problem of factory location, and the considerations that influence it. 2000 w. Ry Age—March 18, 1904. No. 61587.

Fly-Wheels.

Drum-Head Casing for Fly-Wheels. E. E. Clock. Remarks on the power consumed in moving air, and the advantage of casing, describing how the work should be done. Ill. 800 w. Power—March, 1904. No. 61134 C.

Molding Fly-Wheels with Segments. Paul R. Ramp. Describes the manner in which the writer has successfully molded and cast many large wheels. Ills. 1200 w. Foundry—March, 1904. No. 61168.

Grate-Bars.

Making a Lot of Herring-Bone Grate-Bar Patterns. J. L. Gard. Illustrations, with brief description. 600 w. Am Mach—March 17, 1904. No. 61426.

Grinding.

Points in Shop Management. Frank B. Kleinhans. Discusses the uses of the grinding machine, the lining up of work, &c. Ills. 2200 w. Ir Trd Rev—March 3, 1904. No. 61197.

The Grinding Machine *v.* the Lathe. Gives facts and figures showing the advantages and economy of grinding machines. 3500 w. Engr, Lond—Feb. 19, 1904. No. 61154 A.

Hammers.

Pneumatic-Power Hammers. Illustrations, with descriptions of a new type motor-driven with a swing motor. Also other special arrangements. 1200 w. Engng. Feb. 19, 1904. No. 61152 A.

Recent Developments in Power Hammers. H. F. Massey. Read before the Manchester (England) Ass'n of Engrs. (Abstract.) An illustrated article describing early forms and the efforts at improvement in both spring and pneumatic hammers, with information concerning them. 4500 w. Mech Engr—March 19, 1904. No. 61760 A.

Jigs.

Set of Jigs for a Manufacturing Operation. L. O. Danse. Illustrated description of methods adopted in making the steering connection knuckle of the Cadillac auto-

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mobile. 1800 w. Am Mach—March 3, 1904. No. 61207.

Lathes.

An English Design of High-Speed Lathe. Ilustrates a lathe for use with high-speed steel, and gives report of a recent test. 1000 w. Am Mach—March 10, 1904. No. 61326.

14-Inch Hydraulic Boring Lathe. Illustrated description of a heavy lathe intended for boring gun forgings, marine shafting and ingots. Built at Hamilton, Ohio. 1200 w. Engng—March 4, 1904. No. 61415 A.

Hydraulic-Feed 14-Inch Boring Lathe. Illustrated description of an interesting powerful machine. 1200 w. Mach, N Y—March, 1904. No. 61199 C.

Machine Tools.

How Machine Tools Are Developed. John Randol. A criticism of the methods of machine-tool builders. 1800 w. Am Mach—March 24, 1904. No. 61597.

Milling.

Fixtures for Milling a Sewing Machine Arm. H. Robinson. Illustrated description. 900 w. Am Mach—March 24, 1904. No. 61596.

Milling Machines.

A Milling Cutter Working on a New Principle. Illustrates and describes the cutter of the Hess machine. 900 w. Mach, N Y—March, 1904—No. 61201 C.

Screw Milling Machines. H. Liebert. Abstract of a paper read before the Manchester Ass'n. of Engrs. An illustrated article describing this machine, its working and giving information in regard to it. 3500 w. Am Mach—March 17, 1904. No. 61425.

Molding.

Some Notes on Molding Patterns for Hand Work. Walter J. May. Suggestions for the making and storing of foundry patterns. 1200 w. Prac Engr—March 11, 1904. No. 61489 A.

Weights for Holding Down. Thomas D. West. States rules that can be applied to figuring the weight necessary to hold down the cope and core of the mould. 1500 w. Foundry—March, 1904. No. 61167.

Needle Plate.

Making a Sewing Machine Needle Plate. H. Robinson. Illustrates and describes in detail the machine work. 500 w. Am Mach—March 24, 1904. No. 61598.

Punches.

Hardening and Tempering Punches. E. R. Markham. Describes methods used. 800 w. Am Mach—March 3, 1904. No. 61206.

Treatment of Punches. E. R. Markham. Suggestions for the making and use of punches, material best suited, &c. 1200 w. Am Mach—March 10, 1904. No. 61325.

Reversing.

Reversing Gear for Reciprocating Machine Tools (Kehrgetriebe für Werkzeugmaschinen mit Hin- und Hergehender Bewegung). Hermann Fischer. Describing an improved auxiliary reversing gear adapted for use with planers and similar machine tools. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 27, 1904. No. 61610 D.

Salt Mills.

The Alexandershall Salt Mills at Berka-on-the-Werra (Salzmühlenanlage der Gewerkschaft Alexandershall in Berka a/Werra). With plans of the buildings and details of the mills for grinding the potassium salts for fertilizing purposes. The machinery is driven by steam turbines. 1200 w. Zeitschr d Ver Deutscher Ing—March 5, 1904. No. 61614 D.

Shops.

Features of the Michigan Stove Company's Plant and Methods. Illustrated detailed description. 4000 w. Ir Trd Rev—March 3, 1904. No. 61196.

Works of the Smith Premier Typewriter Company, Syracuse, N. Y. Illustrated description of a new plant which is an example of modern practice in factory construction and equipment. 2800 w. Eng Rec—March 5, 1904. Serial. 1st part. No. 61240.

Surfacing.

Getting a Fine Surface in Brass Castings. C. Vickers. Outlines a method the writer has used with success. 1500 w. Am Mach—March 17, 1904. No. 61428.

Tools.

Standard Taps, Reamers and Counterbores. Jos. M. Stabel. Gives tables for fluting taps, fluted reamers, counterbores with inserted pilots, with charts and explanatory notes. 600 w. Am Mach—March 3, 1904. No. 61205.

MATERIALS OF CONSTRUCTION.

Alloys.

The Reports of the Alloys Research Committee. T. K. Rose. Aims to sum up the work of the Committee and to bring forward the portions of the researches which now appear most valuable. 2200 w. Engr, Lond—Feb. 19, 1904. Serial. 1st part. No. 61153 A.

Calcium Steel.

Calcium Steel, the New Rival of Ceramic Products. Information concerning this product, translated from *L'Echo des Mines et de la Metallurgie*. 1500 w. Sci Am Sup—March 19, 1904. No. 61437.

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Cast Iron.

Notes on the Physics of Cast Iron. Richard Moldenke. A review of recent work on the physics of cast-iron showing the lines along which investigations have been made. 3000 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61561.

On Fragments of Cast Iron, Designated as Crystals. Carl Benedicks. Gives results of some investigations made. Ills. 800 w. Ir & Steel Met—March, 1904. No. 61528 D.

The Mobility of Molecules of Cast-Iron. A. E. Outerbridge, Jr. Supplementing an earlier paper. Describes investigations made which disprove the supposed fact that cast-iron under the influence of repeated shocks becomes brittle. Ills. 5500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61555.

Chrome Steel.

Investigations of Chrome Steel (Recherches sur les Aciers au Chrome). Léon Guillet. Giving data and results of investigations into the physical and mechanical properties of chrome steels of various compositions, with microphotographs of etched surfaces. Two articles. 2500 w. Génie Civil—March 5, 12, 1904. No. 61627 each D.

Copper.

The Use of Copper in Engineering Practice. W. Ed. Storey. Abstract of a paper read before the Manchester Ass'n of Engrs. Considers the virtues and faults of copper as a material for the use of engineers. 3800 w. Mech Engr—Feb. 20, 1904. Serial. 1st part. No. 61139 A.

Hardening.

Hardening and Tempering Steel. Abstract of a paper by Prof. A. Stansfield, of McGill University, read before the Canadian Ry. Club. Ills. 1400 w. R R Gaz—March 18, 1904. No. 61457.

High-Speed Steels.

High-Speed Tool Steel—Its Manufacture and Use. J. M. Gledhill. Condensed paper, read before the Coventry Engng. Soc. Describes the method of manufacturing modern crucible steel, and considers the recent rapid progress and development of high-speed steel. 6600 w. Engr, Lond—March 11, 1904. No. 61512 A.

Manufacture and Use of High-Speed Tool Steel. J. M. Gledhill. Read before the Coventry Engng. Soc. Briefly notes the other systems of making steel, especially crucible steel, to make the recent results with high-speed tool steel better understood. 3500 w. Mech Engr—March 19, 1904. Serial. 1st part. No. 61761 A.

The Introduction of High-Speed Steels in Engineering Work-Shops. Frank Fielden. Some suggestions for the success of these improved tools. 2500 w. Engng—March 4, 1904. No. 61411 A.

Lubricants.

A New Method of Testing Lubricants (Ueber eine Neue Untersuchungs methode Flüssiger Schmiermittel). K. Wilkens. Illustrating a device consisting of a paddle-wheel in a closed chamber containing the oil, the resistance to motion of the wheel giving a measure of viscosity. 5000 w. Elektrotech Zeitschr—Feb. 18, 1904. No. 61653 B.

Lubricating Oils and Their Properties—How to Test Them and Detect Adulterations. William M. Davis. Explains how the products of crude petroleum are separated, and the means of testing. 1200 w. Power—March, 1904. No. 61133 C.

Manganese Steel.

The Researches of Guillet upon Manganese Steel (L. Guillets Untersuchungen über Manganstahl). E. Ledebur. Abstract and review of the investigations of Guillet, especially upon manganese steels of low carbon content. 2500 w. Stahl u Eisen—March 1, 1904. No. 61671 D.

Nickel Steel.

The Allotropic Transformations of Nickel Steels (Les Transformations Allotropiques des Aciers au Nickel). O. Boudouard. Tabulated results of tests of steels with 0.12 and 0.80 per cent. of carbon, and gradually increasing contents of nickel. 1200 w. Comptes Rendus—Feb. 8, 1904. No. 61652 D.

Steel Castings.

The Resistance of Steel Castings at Ordinary and Higher Temperatures (Versuche über die Festigkeitseigenschaften von Stahlguss bei Gewöhnlicher und Höherer Temperature). C. Bach. Data and results of tests, with diagrams showing the diminution of strength with increase in temperature. 1200 w. Zeitschr d Ver Deutscher-Ing—March 12, 1904. No. 61619 D.

Testing.

Commercial Tests of Material. E. G. Izod. Read before the Engng. Soc., Univ. College, London. Considers tests to determine the quality of materials for commercial purposes. 2800 w. Engng—March 11, 1904. No. 61507 A.

MEASUREMENT.

Inch-Unit.

The Inch-Unit System. Thomas Parker. Gives a comparison of the inch and centimetre, showing the advantage of the inch, and discussing the disadvantages of the metric system as applied especially to linear units, suggesting the change to the inch as a unit measure. 1200 w. Engr, Lond—March 4, 1904. No. 61421 A.

We supply copies of these articles. See page 319.

Metric System.

The Metric System: Shall It Be Compulsory? Prof. W. Le Conte Stevens. Reviews the history of the standards of measurement in use, and discusses the need of uniformity in the commerce of nations, and the steps that have been taken to that end. 5600 w. Pop Sci M—March, 1904. No. 61165 C.

Recorder.

Apparatus for Studying the Secondary Movements of Vehicles (Méthode pour l'Etude Experimentale des Mouvements Secondaires sur les Véhicules en Marche). M. Sabouret. A combination of pneumatic diaphragm devices for recording the oscillations and other secondary motions of railway and road vehicles. 1200 w. Comptes Rendus—Feb. 29, 1904. No. 61651 D.

Stresses.

The Direct Observation of the Distribution of Stresses (Ueber Unmittelbar Beobachtung der Spannungsverteilung). Otto Hönigsberg. An examination of the location of neutral lines and surfaces in bodies under stress, including optical methods of investigation. 6000 w. Zeitschr u d Oesterr Ing u Arch Ver—March 11, 1904. No. 61643 D.

Thermal Measurements.

New Autographic Method to Ascertain the Critical Points of Steel and Steel Alloys. E. Saladin. Describes the method and apparatus used, and the applications. Ills. 2500 w. Ir & Steel Met—March, 1904. No. 61527 D.

POWER AND TRANSMISSION.

Compressed Air.

Compound Compressor at the St. Pancras Mine at Nürschan (Verbund-Stufen-Kompressor der St. Pankrazzeche in Nürschan). Julius Divis. With diagrams from the steam and air cylinders, showing the action of the Riedler valve gear. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 13, 1904. No. 61649.

The Compressed Air Power Plant at the St. Louis Exposition. Illustrated description of one of the compressors. 750 w. Compressed Air—March, 1904. No. 61526.

The St. Louis Union Terminal Station. Illustrates and describes the plant for supplying compressed air, and notes the applications made. 450 w. Compressed Air—March, 1904. No. 61525.

Crane.

Steam Locomotive Crane of Three Tons Capacity (Fahr barer Dampfkran von 3000 kg. Tragfähigkeit). W. Pickersgill. With details of construction, including arrangement of friction clutches and of variable radius gear. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 20, 1904. No. 61604 D.

Elevators.

Grain Elevators (Getreidespeicher). M. Buhle. A fully illustrated account of modern warehouses and appliances for storing and handling grain, with examples from various parts of Europe and America. Three articles. 10000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Feb. 13, 20, March 5, 1904. No. 61600 each D.

Gearing.

Use of Diagrams and Tables for the Solution of Problems in Gearing. Frank B. Kleinhans. Explanation, illustrated by examples. 1200 w. Mach, N Y—March, 1904. No. 61202 C.

Shaft Hangers.

The "Slot System" of Attaching Shaft Hangers and Fixtures to Concrete-Steel Structures. Henry Parsons Jones. A statement of the general conditions and illustrated discription of the work as carried out in attaching shaft hangers, stringers for counter shafts and other fixtures to a concrete-steel floor system. 2800 w. Eng News—March 3, 1904. No. 61226.

Warehouse Plant.

The Mechanical Plant of the Tietz Warehouse in Berlin (Die Technische Einrichtungen des Warenhauses Hermann Tietz in Berlin). Wilhelm Küppers. Including engines, boilers, hoisting machinery and electric plant of a large modern warehouse with numerous illustrations. 2500 w. Zeitschr de Ver Deutscher Ing—March 12, 1904. No. 61617 D.

STEAM ENGINEERING.

Accumulator.

The Rateau Steam Accumulator (Accumulateur de Vapeur Système Rateau). Ch. Dantin. Describing and illustrating devices for equalizing the pressure of exhaust steam from pumps and other high-pressure machines, enabling it to be used in steam turbines. 3500 w. 1 plate. Génie Civil—March 12, 1904. No. 61628 D.

Auxiliaries.

Steam Power Plant Auxiliaries. Horace E. Sibson. Aims to show how a properly designed feed-water heater can produce a great saving and better efficiency. 1500 w. Sib Jour of Engng—March, 1904. No. 61533 C.

Boilers.

A Study of Marine Water-Tube Boilers (Etude sur les Générateurs Marins à Tubes d'Eau). E. Duchesne. Discussing especially the circulation in boilers constructed with internal circulating tubes,

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giving data and results of experiments with models. 6000 w. Mem Soc Ing Civ de France—Jan., 1904. No. 61674 G.

Evaporative Test of a Babcock & Wilcox Boiler; Comparison of Closed Ash-Pit and Closed Fire-Room Systems of Forced Draft, with Notes on Water-Tube Boilers. Lieut.-Com. B. C. Bryan and Lieut. A. M. Proctor. Ills. 7600 w. Jour Am Soc of Nav Engrs—Feb., 1904. No. 61787 H.

Steam Boilers for Power Plants. W. D. Chester. Considers some of the properties and qualities of the natural elements as required for use in steam generating plants, and the relation of fire-tube and water-tube boilers to power plants. 4700 w. Pro Engrs. Soc of W Penn—Dec., 1903. No. 61541 D.

Water-Tube Boiler. Illustrated description of a new type designed by W. E. Berry, for land work, to deal with dirty feed-water. 1000 w. Engr, Lond—Feb. 26, 1904. No. 61315 A.

Boiler Furnaces.

Comparative Efficiency of Internally and Externally-Fired Boilers. D. W. Robb. Discussing a pair of closely corresponding, independently conducted tests of boilers with external oven furnace and internal corrugated furnace. 3000 w. Engineering Magazine—April, 1904. No. 61688 B.

Condenser.

The Central Condensing Plant of the Burbach Iron Works (Zentralkondensation der Burbacher Hütte in Burbach). Illustrating details of condenser, cooling tower, pumps, and general arrangement for condensing 30,000 kilogrammes of steam per hour. 2000 w. Stahl u Eisen—March 1, 1904. No. 61673 D.

Dampers.

Automatic Damper Regulators. R. T. Strohm. Illustrates and describes several types and explains their advantages. 3000 w. Am Elect'n—March, 1904. No. 61209.

Economizer.

The Green Fuel Economizer. A. H. Blackburn. Read before the Phila. Found. Ass'n. Gives the history of this invention, the advantages claimed, applications, commercial value, and description of the apparatus. 2800 w. Ir Age—March 17, 1904. No. 61430.

Engines.

A Century-Old Colliery Engine—Last Survivor of the Newcomen Type. Benjamin Taylor. Illustrated description of an engine plant at Farme Collieries installed in 1810. 2800 w. Power—March, 1904. No. 61132 C.

An Allen High-Speed Triple-Expansion Engine. Description, with diagram and test figures taken from the official trial. 1400 w. Elect'n, Lond—Feb. 26, 1904. No. 61345 A.

Feed Water.

Water Softening. James O. Handy. Considers the damage done by hard water, methods of softening, the growth and present development, the chemistry, and some municipal water softening plants. Ills. 19500 w. Pro Engrs Soc of W Penn—Dec., 1903. No. 61538 D.

Heat Diagrams.

New Diagrams for the Technical Applications of Heat (Neue Diagramme zur Technischen Wärmelehre). Dr. R. Mollier. Illustrating modifications of the temperature-entropy diagram, with practical applications. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 20, 1904. No. 61605 D.

Heat Transmission.

The Transmission of Heat in Various Parts of Boiler Heating Surface (Der Wärme übergang und seine Verschiedenheiten innerhalb einer Dampfkesselheizfläche). Paul Fuchs. With diagrams showing the results of experiments upon a water-tube boiler, showing the influence of circulation. 4000 w. Zeitschr d Ver Deutscher Ing—March 12, 1904. No. 61618 D.

Injectors.

Injector Troubles and Repairs. Fred H. Colvin. Discusses repairs, with special reference to locomotive injectors. Ills. 3000 w. Mach, N Y—March, 1904. No. 61200 C.

Oil Burners.

Oil Burners and Their Accessories. Amanda T. Jones. Begins a discussion of ways of successfully using petroleum for steam making. 1000 w. Engr, U S A—March, 1904. Serial. 1st part. No. 61215.

Powdered Coal.

Burning Powdered Coal. H. J. Travis. Illustrates and describes apparatus designed for this purpose, pointing out facts brought out in an extensive investigation of various types. 3000 w. Power—March, 1904. No. 61135 C.

Regeneration.

Steam Regeneration: Its History. H. J. Barron. Reviews the work in this field. 1200 w. Sci Am Sup—March 12, 1904. No. 61373.

Speed Regulation.

A Graphical Treatment of the Problem of Speed Regulation (Das Regulierproblem in Vorwiegend Graphischer Behandlung). Dr. A. Koob. An exhaustive graphical treatment of the forces acting in steam engines with regard to the control and regulation of speed. Serial, Part I. Zeitschr d Ver Deutscher Ing—Feb. 27, 1904. No. 61608 D.

We supply copies of these articles. See page 319.

Steam.

The Pressure of Steam Above 100° (Die Spannung des Wasserdampfes über 100°). H. F. Wiebe. An examination of Regnault's experiments, with minor corrections. 1500 w. Zeitschr d Ver Deutscher Ing—Feb. 27, 1904. No. 61612 D.

Steam Economy.

Steam Economy in the Locomotive. J. B. Allfree. A careful treatment of this subject, considering distribution of steam, the volume of cylinder clearance, mean temperature, and material and workmanship. Also general discussion. 13700 w. Pro St. Louis Ry Club—Feb. 12, 1904. No. 61174.

Steam Flow.

Notes on the Flow of Steam Through Nozzles (Beiträge zur Theorie der Dampfströmung durch Düsen). Dr. Prandtl. An examination of the theory of Prof. Lorenz, with comments by Dr. Proell. 2000 w. Zeitschr d Ver Deutscher Ing—March 5, 1904. No. 61616 D.

Steam Plant.

A Textile Mill Power Plant. Eugene B. Whipple. Considers a plant designed to take the place of one that had become overloaded by the increase in buildings and machinery. Ills. 2000 w. Jour Worcester Poly Inst—March, 1904. No. 61535 C.

Steam Ports.

The Dimensions of Steam Ports and Passages for Engines (Die Abmessungen der Steuerkanäle der Dampfmaschinen). M. F. Gutermuth. An examination of the influence of the point of cut-off upon the proportions of steam passages. 3500 w. Zeitschr d Ver Deutscher Ing—March 5, 1904. No. 61613 D.

Steam Turbines.

Efficiency Test of 1250-Kilowatt Steam Turbine for Interborough Rapid Transit Company, New York City. A. M. Mattice. Gives results of a series of performance tests conducted at the builder's works upon the first of the three units selected for the illumination of the New York subway. 3000 w. Power—March, 1904. No. 61131 C.

Methods and Results of Shop-Testing of Steam Turbines. J. R. Bibbins. Describes the tests made by the Westinghouse Machine Co. Ills. 2500 w. Eng News—March 3, 1904. No. 61227.

Phenomena of Flow in the Nozzles of Steam Turbines (Die Strömungserscheinungen in den Düsen der Dampfturbinen). Dr. A. Koob. An examination of pressures and velocities in nozzles of various forms for use in steam turbines. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 20, 1904. No. 61606 D.

Some Notes on the Steam Turbine. Homer M. Jaquays. Aims to give information concerning types and their operation, in such a form that comparisons may be made. Ills. 4000 w. Canadian Soc of Civ Engrs, Adv Proof—Feb., 1904. No. 61160 D.

Steam Turbine of 11,000 Horse-Power. Illustration, with description of turbines under construction for the power station of the Pennsylvania Railroad tunnel from Jersey City to Long Island. 900 w. Sci Am—March 19, 1904. No. 61435.

Steam Turbines, with a Special Reference to Their Adaptability to the Propulsion of Ships. Ernest N. Janson. Ills. 12500 w. Jour Am Soc of Nav Engrs—Feb, 1904. No. 61788 H.

The De Laval Steam Turbine. T. C. Porte. Abstract of a paper read before the Dublin Loc. Soc. of the Inst. of Elec. Engrs. Illustrates and describes the principle on which this turbine is founded, reporting its efficiency. 2500 w. Elect'n, Lond—March 4, 1904. No. 61424 A.

The Riedler-Stumpf Steam Turbine. Walter Rappaport. Briefly notes the different methods for utilizing the heat energy of steam, explaining the principle of the type named. Ills. 1300 w. Elec Rev, Lond—March 4, 1904. No. 61405 A.

The Terry Steam Turbine. Illustrated description of a new form of steam turbine, which resembles in a measure the Pelton water wheel. 2000 w. Ir Age—March 17, 1904. No. 61429.

See also Mechanical Engineering, Automobiles.

Stokers.

Some Performance of Boilers and Chain Grate Stokers with Suggestions for Improvement. A. Bement. Gives the performance of a Babcock & Wilcox, two Heine and one improved Heine boiler as shown in tests; considers the tile-roof furnace, and discusses the characteristics of the chain-grate stoker. General discussion. 14200 w. Jour W Soc of Engrs—Feb., 1904. No. 61545 D.

Superheating.

Superheated Steam. G. D. Seaton. Abstract of a paper read before the Staffordshire Iron & Steel Inst. Facts from the writer's experience showing the saving in cost effected by using superheaters. 1200 w. Ir & Coal Trds Rev—Feb. 26, 1904. No. 61304 A.

Turbines and Superheated Steam. W. H. Booth. Discusses the use of superheated steam in the turbine, its advantages, its steam leak losses, &c. 1600 w. Elec Rev, Lond—Feb. 26, 1904. No. 61301 A.

Test.

Test of a Steam Plant (Untersuchung einer Dampfanlage). K. Vogel. Data

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and results of test of Steinmuller boiler and Lentz steam engine at the works of Siemens & Halske in Berlin. 1200 w. Zeitschr d Ver Deutscher Ing—Feb. 13, 1904. No. 61601 D.

The Equipment of an Engine Test House. R. K. Morcom. Read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Gives a brief account of the evolution of a plant for testing combined sets for electricity stations, and of some of the results obtained. Also discussion. 6300 w. Elect'n, Lond—March 4, 1904. No. 61406 A.

Valves.

Setting Inside Admission Piston Valves. Ira A. Moore. Gives directions. Ills. 1600 w. Loc Engng—March, 1904. No. 61273 C.

Valve Gears. C. C. Major. Discusses the relation between piston and valve position and crank and eccentric angles. Ill. 1500 w. Am Elect'n—March, 1904. No. 61212.

MISCELLANY.

Aeronautics.

Aerial Navigation. O. Chanute. Read before the Am. Ass'n for the Adv. of Science. A review of the present status of the question, the prospects of its solution, and the probable uses of the hoped-for airships. 4300 w. Pop Sci M—March, 1904. No. 61164 C.

M. Archdeacon's Aeroplane. Illustrations of this machine with brief description. 1000 w. Auto Jour—Feb. 27, 1904. No. 61292 A.

Packing.

Note on the Packing of Machinery for Export. Paul Roux. Contributed to the American Chamber of Commerce, Paris. Directions for the preservation of the machines up to the time of delivery. 3000 w. Engng—Feb. 26, 1904. No. 61312 A.

MINING AND METALLURGY

COAL AND COKE.

Breaker.

A Bituminous-Coal Breaker. Lewis Stockett. Illustrates and describes the building and machinery erected at Stockett, Mont., giving results obtained. 1800 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61559.

Briquettes.

Fuel and Mineral Briquetting. Robert Schorr. Information concerning the manufacture of coal and coke, peat, and mineral briquettes, and artificial stone, with costs, &c. 6600 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61553 C.

British Columbia.

The Coalfields of Crow's Nest Pass, British Columbia. E. Jacobs. A fully illustrated account of the district, describing its geology together with the equipment, methods, and importance of the mines. 4000 w. Engineering Magazine—April, 1904. No. 61685 B.

Coal Industry.

See Industrial Economy.

Coal Washing.

The Coal Washer at Howe, Indian Territory. W. R. Crane. An illustrated description of the plant and of the methods of mining and handling the coal. 3500 w. Mines & Min—March, 1904. No. 61252 C.

Coke Ovens.

The Development of the By-Product Coke Oven. Curtis C. Myers. Aims to give a general idea of the coke industry at present, and a brief outline of what it may be reasonable to expect in the future with the development and more general adoption of the by-product or retort coke oven. 4000 w. Sib Jour of Engng—March, 1904. No. 61532 C.

Coke Plant.

By-Product Coke Plant. Dr. W. B. Rothberg. An illustrated general description of the installment of 232 Otto-Hoffman ovens at Lebanon, Penn., by the Lackawanna Iron & Steel Co. 1700 w. Mines & Min—March, 1904. No. 61251 C.

Collieries.

The Mechanical Equipment of Collieries. George H. Winstanley. Abstract of an address before the Manchester Geological and Mining Society. Briefly considers various applications made in modern collieries. 4000 w. Col Guard—Feb. 26, 1904. No. 61303 A.

Colorado.

The Coal Fields of Colorado. Describes the geology and the six important fields. Maps. 5600 w. Bul Colo Sch of Mines—Jan., 1904. No. 61778 D.

Costs.

Estimated Costs of Mining and Coking and Relative Commercial Returns from Operating in the Connellsville and Walston-Reynoldsville Districts, Pennsylvania. Eduard V. D'Invilliers. 4500 w. Trans

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Am Inst of Min Engrs—Feb., 1904. No. 61556.

Handling.

Coal and Coke Handling. Alfred Ernst. Illustrated description of the improved machinery for stamping and charging the coal in the coke plant of the Lackawanna Iron & Steel Co., at Lebanon, Penn. 2200 w. Mines & Min—March, 1904. No. 61250 C.

Japan.

Japanese Coal Mines. K. Gonekra. A brief illustrated outline of the mining department of the Kokkaido Colliery & Railway Company, Japan. 5000 w. Mines & Min—March, 1904. Serial. 1st part. No. 61248 C.

COPPER.

Converters.

Bessemer Copper Converters. C. H. Glasser. Refers to the trough or barrel type of converter, discussing its advantages and disadvantages, stating the objections to the hydraulic systems that have developed in actual practice, and presenting supposed advantages by substituting the electric for the hydraulic equipment. 3500 w. Eng & Min Jour—March 17, 1904. No. 61444.

Electrolysis.

Note on the Relation Between Arsenic and Electro-Motive Force in Copper-Electrolysis. L. Webster Wickes. Summary of experimental investigations. 1200 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61566.

Extraction.

Wet Methods of Extracting Copper at Rio Tinto, Spain. Charles H. Jones. Describes the methods of leaching and precipitation now used at Rio Tinto. Ills. 2700 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61571.

The Payne-Gillies Copper Process. F. Danvers Power. Describes this process which is suitable for the extraction of copper from poor ores which are too silicious for smelting purposes and which cannot be concentrated mechanically at a profit. 1200 w. Eng & Min Jour—March 3, 1904. No. 61218.

GOLD AND SILVER.

Assaying.

A System of Fusing Ores for Assaying. Arthur Lachman. Abstract from the *California Jour. Tech.* Gives the writer's scheme for calculating in advance the best flux for any given ore. 2000 w. Min & Sci Pr—March 5, 1904. No. 61376.

British Columbia.

Hydraulic Mining in Cariboo, B. C. From the annual report submitted by J. B. Hobson, showing details of large operations in progress in Cariboo. 1200 w. Min & Sci Pr—Feb. 20, 1904. Serial. 1st part. No. 61113.

California.

Gold Mining in Trinity County. E. H. Nutter. A record of production dating back a half-century. Ills. 2500 w. Pacific C Min—Feb. 27, 1904. No. 61281.

Cyaniding.

Cyaniding in the Southern States. Ernest Gayford. An interesting account of recent work at the Howie mine in North Carolina. 1600 w. Min & Sci Pr—Feb. 27, 1904. No. 61266.

Notes Upon Preliminary Tests and Cyanide-Treatment of Silver Ores in Mexico by the MacArthur Forrest Process. John F. Allan. Gives practical hints on preliminary tests and calls attention to a possible enlarged field for the cyanide process in the treatment of some silver ores. 7200 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61569 C.

The Hendryx Electro-Cyanide Process. C. M. Fassett. Describes this process, stating its claims, and reporting its success. 1200 w. Min & Sci Pr—Feb. 27, 1904. No. 61265.

Dredging.

Gold Dredging Under Difficult Conditions. F. Winter Taylor. Discusses the design of a dredge that is to be worked under exceptionally hard conditions. Gives plan. 2500 w. Eng & Min Jour—March 24, 1904. No. 61701.

Native Gold.

Original Native Gold in Igneous Rocks. Walter Harvey Weed. Calls attention to several significant occurrences of gold in igneous rocks. 2000 w. Eng & Min Jour—March 17, 1904. No. 61445.

New Zealand.

Gold and Coal in New Zealand. Editorial review of the interesting Government returns for the last year. Gold constitutes 60½ per cent., and coal 23 per cent. of the mineral production. 2000 w. Engng—Feb. 26, 1904. No. 61310 A.

Queensland.

The Occurrence of Gold in Association with Antimony in Queensland. B. Dunstan. Information from the Survey Reports issued by the Mines Department. 1600 w. Queens Gov Min Jour—Jan. 15, 1904. No. 61161 B.

Slimes.

A Proposed Filter-Press Slimes Plant. Francis L. Bosqui. Report on the filter-press treatment of slimes at the Liberty Bell mine, Telluride, Colo. 4000 w.

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Trans Am Inst of Min Engrs—Oct, 1903. No. 61568.

The Slime Problem. T. Lane Carter. States the advantages of a slime plant and considers recent installations on the Rand. 2000 w. Eng & Min Jour—March 17, 1904. No. 61443.

Smelting.

The Electric Smelting of Complex Sulphides. A. A. Beadle. A brief description of the more important electrometallurgical methods of treatment of lead, zinc, silver ores. 2000 w. Eng & Min Jour—March 24, 1904. No. 61703.

Tailings.

Tailings Elevators. W. H. Wood and E. J. Laschinger. Abstracted from the Jour. of the Mech. Engrs. Assn. of the Witwatersrand. Treats of appliances, made necessary by the flat nature of the ground, under the subjects of tailings wheels, tailings pumps, bucket belt elevators, and air-lift pumps. Ills. 2700 w. Eng & Min Jour—March 24, 1904. No. 61704.

IRON AND STEEL.

Basic Process.

Basic Open-Hearth Steel Castings. L. L. Knox. Read before the Pittsburg Found. Assn. Claiming that basic open-hearth steel gives castings equally as good as acid open-hearth steel, giving a description of the process in an open-hearth furnace using producer gas. 2500 w. Foundry—March, 1904. No. 61170.

Blast Furnaces.

A Decade in American Blast Furnace Practice. F. Louis Grammer. Discusses briefly the tendencies in the methods of administration as well as the conditions governing supremacy as affecting the aims of the manager, and considers the advances made during the last ten years. 6500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61570.

Notes on the Behavior of Zinc in the Blast Furnace. John J. Porter. Deals with ores containing zinc, describing the reactions of zinc in the blast furnace, and the influence of the zinc upon the working of the furnace. 3000 w. Ir Age—March 24, 1904. No. 61575.

Stock Distribution and Its Relation to the Life of a Blast-Furnace Lining. David Baker. The results of mechanical charging are discussed and compared with the hand-barrow system, and an illustrated report of the writer's experience. 2200 w. Eng News—March 24, 1904. No. 61713.

Briquetting.

The Briquetting of Iron Ores. (Ueber Brikettierung von Eisenerzen) Dr. Alois Weiskopf. A discussion of the various binding materials employed, together with a list of patents and brief bibliography of the subject. 4000 w. Stahl u Eisen—March 1, 1904. No. 61670 D.

Electric Smelting.

See Electrical Engineering. Electrochemistry.

Heating Pits.

Doors for Heating Pits. T. H. Lauder. Read before the West of Scotland Ir. and Steel Inst. Illustrates and describes a new type of door and appliances for handling doors of large dimensions. 1500 w. Ir & Coal Trds Rev—March 4, 1904. No. 61423 A.

Ore Supplies.

The World's Iron Ore Supplies. Bennett H. Brough. Abstract of lecture and discussion. 4400 w. Pamphlet—Jour of West of Scotland Iron & Steel Inst. No. 61515 A.

Philippines.

Iron Making in the Philippines. Extract from the report of H. D. McCaskey. Gives an illustrated description of a primitive blast-furnace in the Angat iron region, Bulacan, with information concerning the industry. 6000 w. Ir Age—March 3, 1904. No. 61159.

Rolling Mills.

The Small Mill Plant vs. the Large Mill Plant. D. F. Nisbet. Examines some of the usages as to their values and efficiencies, as found in types of rolling mills taken as examples. A comparison of old and modern practice. 5500 w. Ir Trd Rev—Feb. 25, 1904. No. 61104.

Specifications.

The Standardization of Specifications for Iron and Steel. Recent Progress in America and England. William R. Webster and Edgar Marburg. Outlines the history of the movement to secure uniformity on the part of technical societies in the United Societies, and gives a brief review of the present situation in England. 1800 w. Trans Am Inst of Min Engrs—March, 1904. No. 61560.

Vermilion.

Methods of Mining in the Vermilion Iron District of Minnesota. Kirby Thomas. Illustrates and describes the working of these mines as examples of the best art in mining. 1600 w. Min & Sci Pr—Feb. 20, 1904. No. 61114.

MINING.

Ankylostomiasis.

Ankylostomiasis: A Forewarning. Walter C. C. Pakes. An interesting paper on this disease, which especially attacks miners, with discussion. 7500 w. Jour of

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Chem, Met, & Min Soc of S. Africa—Jan., 1904. No. 61501 E.

Arizona.

A Trip Through Arizona. Prof. Arthur Lakes. Illustrates and describes interesting desert scenery showing the relation it bears to the geology and the mining interests of the region. 3500 w. Mines & Min—March, 1904. No. 61249 C.

Battery Frames.

A Cantilever Battery Frame. Ira C. Boss. Drawing and description of this design, with information concerning it. 1300 w. Eng & Min. Jour—March 10, 1904. No. 61359.

China.

Mining Regulations for the Jehol Region, China. A portion of the regulations covering mining in this district as suggestive of conditions in China. 1000 w. Eng & Min Jour—March 17, 1904. No. 61442.

Electric Power.

Electric Haulage in Metal Mines. General remarks, with an illustrated description of the haulage system used by the United Gold Mines Co., of Victor, Colo. 1500 w. Bul Colo Sch of Mines—Jan., 1904. No. 61780 D.

Electric Mine Locomotives. William L. Affelder. Read before the W. Penn. Cent. Min. Inst. An illustrated article considering traction, third-rail, and sprocket locomotives, their development, and the conditions to which they are adapted. 8000 w. Mines & Min—March, 1904. No. 61254 C.

Electric Winding Machines. Maurice Georgi. Abstract of a paper read before the Glasgow Local Sec. of the Inst. of Elec. Engrs. Discusses the advantages and disadvantages of electric winding, and gives an illustrated description of Mr. Ilgner's system of compensation. 2200 w. Elect'n. Lond—March 18, 1904. No. 61766 A.

Polyphase Hauling Plant at Bolsover Colliery. Illustrated description of recently installed plant. 800 w. Col Guard—March 4, 1904. No. 61409 A.

Rules for the Installation and Use of Electricity in Mines. Gives rules drawn up by the Departmental Committee. 8000 w. Elect'n, Lond—Feb. 19, 1904. No. 61146 A.

Rules of the Electricity in Mines Committee—An Analysis and a Criticism. E. Kilburn Scott. 2000 w. Ir & Coal Trds Rev—Feb. 12, 1904. Serial. 1st part. No. 61148 A.

The Electrical Mining Installations of the Hélios Electrical Company. Emile Guarini. Gives an account of the work of this company, and illustrated descriptions of installations made. 4000 w. Elec Rev, N. Y—March 12, 1904. No. 61383.

Geological Phenomena.

A Sketch of the Geology and Economics Along the Union Pacific Railway from Cheyenne to Ogden. A. Lakes. A brief popular account of what may be seen generally from the car windows along this route. Ills. 1500 w. Min Rept—March 10, 1904. No. 61384.

Korea.

Mining and Business Interests in Korea. S. Herbert Williams. Information concerning the minerals found and methods of mining; also the other industries and products. Ills. 1800 w. Eng & Min Jour—March 3, 1904. No. 61216.

Laboratory Work.

Laboratory Work Under Smelting Conditions. K. Friedrich. A short description of the construction of a small gas-heated reverberatory furnace, giving a report of its efficiency and application. Ills. 1800 w. Eng & Min Jour—March 24, 1904. No. 61702.

Metal Mines.

Gases in Metalliferous Mines. Harry A. Lee. Read before the Colorado Sci. Soc. Describes conditions as found at the Happy Thought mine, near Crude, Colo. 3000 w. Min Rept—March 3, 1904. No. 61269.

The Economic Ratio of Treatment Capacity to Ore Reserves. H. C. Hoover. Discusses mine development with the view of securing the maximum profit. 2400 w. Eng & Min Jour—March 24, 1904. No. 61700.

Mill Water.

Economy in Mill Water. Jesse Scobey. Read before the Colorado Sci. Soc. An illustrated article reviewing a plant at Washington, Arizona, where a saving of 97 per cent. of the water in circulation was made. 3000 w. Min Rept—Feb. 25, 1904. No. 61103 C.

Mining Methods.

Methods of Mining and Timbering in Large Ore Bodies in British Columbia and Michigan. Norman W. Parlee. Describes and discusses methods and their modifications as carried out in mines where the writer has worked. Ills. 7500 w. Can Soc of Civ Engrs, Adv. Proof—Feb. 25, 1904. No. 61191 D.

Ore Carriers.

Schists and Slates as Ore Carriers. Arthur Lakes. An illustrated article giviug information from the writer's experiences in Colorado, Wyoming, Nevada, Arizona and North Carolina. 2000 w. Min & Sci Pr—March 5, 1904. No. 61375.

We supply copies of these articles. See page 319.

Ore Deposits.

A Peculiar Ore Deposit. E. A. Colburn. Illustrates and describes an ore shoot in Ajax mine, Cripple Creek, Colo. 800 w. Min & Sci Pr—March 19, 1904. No. 61747.

Ore in Anticlinals, as at Bendigo, Australia, and Tombstone, Arizona. Arthur Lakes. Illustrates and describes the geology of ore deposits in anticlinals. 1400 w. Min & Sci Pr—March 19, 1904. No. 61745.

The Genesis and Character of Ore Deposits. W. H. Storms. On the various forms of ore deposit, and the importance to miners of a knowledge of their occurrence. 2000 w. Min & Sci Pr—March 10, 1904. No. 61746.

Ore-Formation.

Osmosis as a Factor in Ore-Formation. Halbert Powers Gillette. Aims to show that "osmosis" supplemented by convection-currents have been the principal agencies that have gathered the scattered particles of rare minerals into the larger masses called ore. 1600 w. Trans Am Inst of Min Engrs—Oct., 1904. No. 61567.

Prospecting.

The Theory of Ore Deposits Applied to Prospecting. E. B. Wilson. Gives illustrations of manner of ore formation from crystallization of solutions. 2500 w. Mines & Min—March, 1904. Serial. 1st part. No. 61255 C.

Re-grinding.

Notes on Some Re-grinding Machines. Martin Schwerin. Gives results of a series of tests on four types of re-grinding machines, with observations on this feature of ore dressing. 2800 w. Eng & Min Jour—March 10, 1904. No. 61358.

Santiago.

Mineral Deposits of Santiago, Cuba. Harrison Sonder. A sketch of the principal mineral deposits near this place. Ills. 2500 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61554.

Shaft Sets.

The Framing of Rectangular Shaft Sets. Wilbur E. Sanders. Illustrates and describes the methods of framing almost universally accepted as affording the greatest possible strength. 2000 w. Eng & Min Jour—March 10, 1904. No. 61357.

Shaft Sinking.

Note on the Cost and Speed of Sinking the East Shaft of the New Kleinfontein Co., Benoni, South Africa. Edward J. Way. Tabulated data. 300 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 61562.

Shaft Sinking Through Water-Bearing Permian, Triassic and Cretaceous Strata. Considers the methods used in sinking shafts through the more consolidated secondary rocks, which are generally very water-bearing. Ills. 4300 w. Col Guard —March 4, 1904. No. 61408 A.

Witwatersrand.

Observations on the Metallurgical Practice of the Witwatersrand. Harry S. Denny's paper is discussed at length by Wager Bradford. 4400 w. Jour of Chem, Met & Min Soc of S. Africa—Jan, 1904. No. 61502 E.

Winding.

Endless Chain Winding and Vertical Shafts. Illustrated description of method devised by Prof. O. C. von Verbo of replacing rope and cage winding, by an endless chain of links, on to which the pit tubs are hooked at certain intervals. 700 w. Col Guard—March 11, 1904. No. 61503 A.

Wyoming.

Leading Mines of Wyoming. An illustrated article reviewing briefly the principal mining camps. 2500 w. Pacific C Min—Feb. 27, 1904. No. 61280.

MISCELLANY.

Alumina.

A Method for the Direct Determination of Alumina. Charles E. Rueger. Gives comments on methods in general use and recent facts concerning their accuracy, and describes method used by the writer and the results. 2200 w. Eng & Min Jour—March 3, 1904. No. 61217.

Fireclay.

Fireclay. A study of the clays of Clinton County, Pa., explaining what constitutes fireclay, and how it is deposited. 2000 w. Mines & Min—March, 1904. No. 61253 C.

Manganese.

Some Manganese Deposits in the Gingin, Degilbo, and Warwick Districts. Lionel C. Ball. Reports of these districts, as a part of a scheme to have all manganese deposits inspected and reported. Map. 3800 w. Queens Gov Min Jour—Jan. 15, 1904. No. 61162 B.

Spain.

Some Chemical and Metallurgical Industries in Spain. Notes on the sulphate of ammonia industry, sulphate of copper, dynamite, vitriol, sulphur, alkalies, arsenic, tartaric acid, &c. 2000 w. Engng—March 18, 1904. No. 61767 A.

Tin.

Some Notes Concerning Tin. John W. Gray. Concerning the location of tin deposits, methods of extraction, the distribution and production of the metal. 2000 w. Min & Sci Pr—March 19, 1904. No. 61748.

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RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accident.

Train Accidents in the Quarter Ending Sept. 30, 1903. Information of interest from the last bulletin of the Interstate Commerce Commission. 1200 words. Eng News—March 3, 1904. No. 61222.

Freights.

I. The Best Way to Keep Freights on Time, from a Conductor's Standpoint. T. H. Beacom. II. How to Keep Way Freights on Time, from an Agent's Standpoint. R. F. Weeks. Two papers discussed together. Also III. The Best Way to Handle Freights so That They Will Be on Time, from Train Dispatcher's Position. 9500 w. Pro Iowa Ry Club—Jan. 19, 1904. No. 61175.

Organization.

Some Thoughts and Suggestions on Railroad Organization and Management. A. M. Waitt. Considers some of the features of organization in England, comparing with America, and discusses the needs of large systems, offering suggestions. 4000 w. R R Gaz—March 11, 1904. No. 61361.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

A Storage Air Brake System Adopted at St. Louis. An illustrated description of this installation. 2400 w. Compressed Air—March, 1904. No. 61524.

New York Air Brake Co.'s Compensating Valve for High Speed Brakes. Illustrated description of a "compensating valve" recently designed by the New York Air Brake Co., to be used in high speed brake service. 600 w. Loc Engng—March, 1904. No. 61275 C.

Axle Loads.

Distribution of Loads on Locomotive Axles. A. T. J. Kersey. Gives mathematical investigation made to determine the distribution of the loads on the axles of a six-coupled tank engine. 1200 w. Engr, Lond—March 11, 1904. No. 61511 A.

The Dopp Adjustable Locomotive Scales (Die Dopp'sche Aichfähige Raddruckwage). F. Dopp, Jr. Illustrating an improved form of scales for weighing the distribution of pressure upon the wheels of a locomotive or railway carriage. 1200 w. Glasers Annalen—March 15, 1904. No. 61639 D.

Brake Control.

Brake Control of Heavy Capacity, Freight-Cars on Grade. T. A. Hedendahl. Discusses the influences bearing on the subject, with recommendations. General discussion. 6000 w. Pro Rocky Mt Ry Club—Feb., 1904. No. 61521 D.

Brakes.

Higher Braking Power for Freight Cars. Robert H. Blackall. Shows that a greater braking power is much to be desired to meet present conditions, and that it can be increased. General discussion. 9000 w. Ry Club of Pittsburg—Jan., 1904. No. 61192 C.

Cars.

The Lawson Dump Car. Illustrated detailed description. 900 w. R R Gaz—March 11, 1904. No. 61367.

Counterbalancing.

Counterbalancing Locomotives. G. E. Lee. Explains a method the writer has used with good results, giving an example from actual experience. 800 w. Mach, N. Y—March, 1904. No. 61204 C.

Engine Defects.

Locating Defects in Schenectady Cross Compound Engines. V. C. Randolph. Suggestions. 900 w. Loc Engng—March, 1904. No. 61274 C.

Fuel Tests.

Fuel Tests on the Furness Railroad, England. From a paper by W. F. Pettigrew, giving results of a series of tests made to determine the fuel value of several grades of coal. 1500 w. R R Gaz—March 4, 1904. No. 61247.

Inspection Cars.

Gasoline Inspection Cars for Railways. Illustrated descriptions of two new forms recently appearing in London. The inventions of Robert W. A. Brewer, and of Frederick R. Simms. 800 w. Sci Am Sup—March 19, 1904. No. 61438.

Locomotives.

Atlantic Type Passenger Locomotive for the Wabash Railway. Illustrations, principal dimensions and description of engine of the 4-4-2 type to handle heavy traffic. 700 w. Eng News—March 17, 1904. No. 61448.

Combustion Chambers in Italian Locomotives. Information concerning designs now in preparation which give a saving in repairs, and in earning time of the engines. 900 w. Engr, Lond—March 18, 1904. No. 61773 A.

Compound Locomotives in France. M. Edouard Sauvage. Details of locomotive practice, especially considering the four-

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cylinder compound. Many tables and illustrations. 12000 w. Inst of Mech Engrs —March 18, 1904. No. 61775 D.

Consolidation Locomotive for Southern Railway. Illustrations, general dimensions and description. 300 w. Ry Age—March 4, 1904. No. 61268.

Express Passenger Locomotive for the North-Eastern Railway. Illustrations, with principal dimensions of a new type of locomotive, the largest and most powerful ever built in England. 800 w. Engng —Feb., 19, 1904. No. 61150 A.

Heavy Freight Locomotive of the Atchison, Topeka & Santa Fé Railroad (Schwere Güterzuglokomotive der Atchison, Topeka & Santa Fé Bahn). H. Metzeltin. Illustrated description of new tandem-compound engines with table comparing American and European locomotives. 1800 w. Zeitschr d Ver Deutscher Ing—March 5, 1904. No. 61615 D.

New Six-Coupled Express Engine for the Great Western Railway. Charles Rous-Marten. Illustrated description. 800 w. Engr, Lond—March 18, 1904. No. 61774 A.

Pacific Type Engine, Union Pacific R R. Illustrated description of a recently built engine for heavy traffic. 500 w. Ry and Engng Rev—Feb. 27, 1904. No. 61136.

Six Coupled Passenger Locomotive. Illustrated description of a new design, 4-6-2 (Pacific) type, a very large and heavy engine. 1000 w. Am Engr & R R Jour—March, 1904. No. 61198 C.

Trials of the Great Western French Engine. Charles Rous-Marten. An interesting report of the satisfactory performance of this engine on two trips. 2500 w. Engr, Lond—March 4, 1904. No. 61418 A.

Two Locomotive Experiments. Corrects misconceptions in regard to experiments made with the new engine No. 102, La France, and the Decapod designed for suburban traffic on the Great Eastern Railway. 2800 w. Engr, Lond—Feb. 19, 1904. No. 61157 A.

Lubrication.

The Lubrication of Locomotive Valves and Cylinders. D. R. MacBain. Believes the trouble to be largely caused by wet steam. General discussion. 1600 w. Pro W Ry Club—Feb. 16, 1904. No. 61518 C.

Superheating.

The Use of Superheated Steam on Locomotives. A critical note on the Schmidt system, by M. Teuscher, and a long answer by Mr. Otto Berner, both appearing in the *Zeitschrift des Vereines deutscher Engenieure*. 12400 w. Bul Int Ry Cong—Feb., 1904. No. 61127 E.

Traction.

The Use of Double Traction (Note sur l'Emploi de la Double Traction). M. Herdner. A discussion of the action of two locomotives hauling a train, showing the practicability of dividing the work to advantage between the two machines. 4000 w. Rev Gen des Chem de Fer—March, 1904. No. 61676 H.

Train Lighting.

The Dick System of Lighting Trains by Electricity. Emile Guarini. Illustrated description. 800 w. Sci Am Sup—March 26, 1904. No. 61723.

Trials.

Trial Runs of Modern Locomotives. A. von Borries. A report of trials made in 1902, having as object the experimental comparison of the four cylinder compound locomotive on the von Borries system, with the most recent type of locomotive with superheated steam on the Schmidt-Garbe system. 4000 w. Bul Int Ry Cong —Feb., 1904. No. 61128 E.

Tunnel Ventilation

The Farcot Ventilator. (Ventilateurs Farcot). Ed. Sauvage. Data and results of tests of a large Farcot fan used for ventilating the Albespeyre tunnel in the south of France. Details of the machinery are given. 7500 w. Bull Soc d'Encour—Jan., 1904. No. 61644 G.

The Ventilation of the Albespeyre Tunnel (Aération du Tunnel de l'Albespeyre, Lozère). Illustrating an installation of the Saccardo system, with Farcot fan on the line of the Paris, Lyons, Mediterranean railway between Langogne and Alais, in southern France. 1200 w. Génie Civil—March 12, 1904. No. 61629 D.

Ventilation.

Ventilation of Baldwin Locomotive Works Engine House. Illustrated description of the system of carrying away the smoke and gases from locomotives. 500 w. Ry Age—March 25, 1904. No. 61751.

Wheels.

Chilled Cast Iron Car Wheels. J. S. Ferguson. Considers improvements made, outlining the practice of wheel casting as used by a reliable company, and the tests. 2500 w. Pro Rocky Mt Ry Club—Feb., 1904. No. 61522 D.

Specifications for Cast Iron Car Wheels. A copy of the standard specifications proposed by the committee of the American Society for Testing Materials. 2000 w. Ry & Engng Rev—Feb., 27, 1904. No. 61137.

Wrecking Appliances.

Modern Wrecking Appliances. Illustrates and describes recent improvements. 2200 w. Ry & Engng Rev—March 12, 1904. No. 61394.

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Wrecking Outfits on the Pennsylvania. Describes the wreck trains and outfits, illustrating details of special tools carried. 2500 w. R R Gaz—March 11, 1904. No. 61360.

NEW PROJECTS.

China.

The Location of the First Division of the Hankow-Canton Ry. Jesse W. Miller. An interesting account of this survey and information concerning the country and its inhabitants. 3000 w. Eng News—March 17, 1904. No. 61453.

Genoa, Italy.

The Proposed New Railway Lines for the Development of the Port of Genoa, Italy. Charles R. King. Describes existing lines and the new projects for providing easier and cheaper transit inland. Ills. 2000 w. Eng News—March 24, 1904. No. 61705.

Improvements.

Pennsylvania Low-Grade Line Down the Susquehanna. Illustrated description of an important improvement made in the construction of a new double-track freight line, especially describing the stone bridge at Shocks Mills, Pa. 2200 w. R R Gaz—Marsh 11, 1904. No. 61364.

Russia.

Russian Railway Building in 1904 (Russlands Eisenbahnbauten im 1904). Brief tabulated statement of the amount to be expended and its distribution. 800 w. Glasers Annalen—Feb. 15, 1904. No. 61-634 D.

Switzerland.

The Albula Railway. The first of a series of illustrated articles giving a detailed technical account of the line joining Thusis and the Engadines. Involves very difficult construction work. 2500 w. Engr, Lond—March 4. 1904. Serial. 1st part. No. 61417 A.

Wabash.

The Wabash Extension into Pittsburg. Gives the history of this new line, with illustrations and descriptions of interesting construction work. 3800 w. R R Gaz—March 11, 1904. No. 61363.

PERMANENT WAY AND BUILDINGS.

Ballast.

Ballast. From the report of a committee to Am. Ry. Engng. & Main. of Way Assn. Explains the requirements of ballast, and considers the materials available. 3300 w. Eng Rec—March 26, 1904. No. 61740.

Coal Piers.

The Construction and Operation of Coal Piers. Abstract of a committee report prepared for the convention of the Am. Ry. Engng. and Main. of Way Assn. 5000 w. Eng News—March 17, 1904. No. 61452.

Construction.

The Construction of the Texas and Oklahoma Railroad. Robert F. Powell. Describes the construction work, illustrating details of interest. 2400 w. Eng Rec—March 5, 1904. No. 61239.

Curves.

See Civil Engineering, Measurement.

Drains.

Pillar Drains for Holding Banks. W. J. Cudworth. States the conditions which indicate a need of better drainage, and illustrates and describes the pillar drains used in England. 1000 w. R R Gaz—March 11, 1904. No. 61366.

Engine Houses.

A Comparison of Circular and Rectangular Engine Houses. Editorial discussion of George P. Nichols' paper before the Western Railway Club, with extracts. 3000 w. Eng News—March 3, 1904. No. 61223.

New Engine House Construction on the Intercolonial Ry. Illustrates and describes the engine house at St. John, N. B., giving information of a number of others. 1300 w. Ry & Engng Rev—March 12, 1904. No. 61393.

Square Roundhouses. George P. Nichols. Aims to show the disadvantages of the usual roundhouse form, and to demonstrate the superiority of the square house. General discussion. Ill. 3500 w. Pro W Ry Club—Feb. 16, 1904. No. 61517 C.

Improvements.

An Analysis of the Value of Recent Improvements on the Union Pacific. J. B. Berry. Abstract of a paper presented at the meeting of the Am. Ry. Engng. & Main. of Way Assn. Shows in a general way the work done, and gives a study of the operating statistics, summarizing the advantages and savings. 3500 w. R R Gaz—March 25, 1904. No. 61715.

Improvements on the Denver & Rio Grande. Brief description, with illustrations, of grade reductions, elimination of curvature, re-location, etc. 1400 w. R R Gaz—March 25, 1904. No. 61714.

The Improvements on the Big Four Line between Lawrenceburg Junction and Sunman. Describes the relocation of the line, grade reductions, and shortening of the line, explaining why the changes were made. Ills. 1300 w. Eng Rec—March 5, 1904. No. 61237.

Location.

The Location of the Knoxville, La Follette and Jellico Railroad, of the Louisville and Nashville System. W. D. Taylor.

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Aims to show the considerations that determined each important step in the layout of an important engineering work. Maps. 7700 w. Pro Am Soc of Civ Engrs —Feb., 1904. No. 61177 E.

New Construction.

The Chicago, Indianapolis and St. Louis Short Line. Illustrates and describes a new cut-off being constructed at a cost of $3,000,000. It will reduce the distance from Indianapolis to St. Louis by 12 miles. 3300 w. R R Gaz—March 11, 1904. No. 61368.

Rails.

Specifications for Bessemer Steel Rails. Gives the specifications adopted by Am. Ry. Engng. & Main. of Way Assn. at the Chicago meeting. 900 w. Eng News—March 24. 1900. No. 61706.

Shops.

Fundamental Principles of Effective Organization and Economic Management Applied to R. R. Car-Repair Shops. Charles Streicher. A consideration of this subject, followed by general discussion. 5500 w. Pro Pacific C Ry Club—Feb. 20, 1904. No. 61516 C.

The Canadian Pacific Railway Shops at Montreal. An illustrated description of the power plant, electric installation, transportation, water system, heating, general construction and equipment. 4000 w. Eng Rec—March 19, 1904. Serial. 1st part. No. 61468.

The East Moline Shops of the Rock Island. An illustrated account of the electrical distribution and speed control, the location of machine tools and a description of the smith shop and store house. 3000 w. Ry Age—Feb. 26, 1904. No. 61108.

Signals.

Performance of Automatic Block Signals Under Unfavorable Conditions. H. S. Balliet. The first of a series of articles discussing the maintenance and operation of automatic signals. 2500 w. R R Gaz—March 25, 1904. Serial. 1st part. No. 61718.

Simplifying Night Signals and Shortening Block Sections. Criticism of points in a recent paper by A. M. Schoyer, before the Ry. Club of Pittsburg. 1500 w. R R Gaz—March 18, 1904. No. 61455.

Terminals.

New Passenger and Freight Terminals at Atlanta, Ga. Illustrates and describes a somewhat unusual arrangement, due to the peculiar shape of the property and differences in level of street and tracks. 800 w. R R Gaz—March 18, 1904. No. 61458.

Proposed Improvements in St. Louis Terminals. A. P. Greensfelder. Plans and description of the various improvements already made or contemplated, and an account of methods of handling the immense traffic. 7700 w. Jour Assn of Engng Socs —Jan., 1904. No. 61530 C.

The Union Terminal Arrangements at Washington. Illustrated explanation of work to be carried out with a view to securing beauty as well as usefulness, at a cost of about $20,000,000. 2500 w. Ry Age —March 18, 1904. No. 61590.

Ties.

Recent Investigations with Treated Ties. An article by Dr. Hermann von Schrenck, appended to the report of the Committee on Ties of the Am. Ry. Engng. & Main. of Way Assn. 1100 w. Eng Rec —March 26, 1904. No. 61734.

Tunnels.

See Civil Engineering, Construction.

Union Pacific.

Reduction of Gradient and Elimination of Distance, Curvature, and Rise and Fall on Union Pacific Railroad. J. B. Berry. An interesting account of extensive revision work so far accomplished, the methods adopted, and related matter of interest. 12500 w. Ry Age—March 18, 1904. No. 61591.

TRAFFIC.

Asia.

The Railways of Central Asia (Die Mittelasiatische Eisenbahn). P. Romanow. A general description of Russian railway developments between the Caspian Sea and the frontiers of Afghanistan, India, and China; with map. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 13, 1904. No. 61602 D.

Prussia.

The Administration of the Railway Service for the Year 1904 (Etat der Eisenbahn-Verwaltung für das Etatsjahr 1904). The official establishment of the Prussian railway system for 1904; tabulating the officials, expenditures and general outline of work for the year. Three articles. 10,000 w. Glasers Annalen—Feb. 15, Mar. 1, 15, 1904. No. 61631 each D.

Transsiberian.

The Siberian Railway and its Tributary Territory in Eastern Asia (Die Sibirische Eisenbahn und ihr Auschlussgebiet in Ostasien). Lieutenant Taubert. A general description of the journey from Berlin to Port Arthur, with a discussion of the country to be developed by the commercial operation of the line. 5000 w. Glasers Annalen—March 1, 1904. No. 61635 D.

The Siberian Railway and Its Results. Discusses this railway in connection with its influence on trade, and its effect on the present war, features of construction, etc. 3000 w. Engng—March 18, 1904. No. 61771 A.

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STREET AND ELECTRIC RAILWAYS

Bagdad.

Details of the New Constantinople-Bagdad Railway. Information concerning this new line, which, with its branches, will have a length of 1,500 miles. 900 w. Sci Am Sup—March 5, 1904. No. 61282.

Boston.

The Boston Transit Problem. Illustrated detailed description of the construction of this great engineering work, with explanation of the way it meets the needs of transportation of the city. 2800 w. Ry Age—March 18, 1904. No. 61586.

Brake Service.

Method of Making Competitive Tests of Capacity, Power Consumption, and Efficiency of Motor-Driven Compressors for Brake Service. Edward H. Dawson. Describes method. 1700 w. St Ry Jour—Feb. 27, 1904. No. 61118 C.

Cars.

A Double-Deck Car for Rapid Transit. Remarks on the advantages of the double-deck cars, with illustrated description of a design by James L. Getaz. 800 w. Sci Am—March 19, 1904. No. 61434.

Chicago Tunnels.

Electric Traction for Freight Transportation in the Chicago Telephone Tunnels. An illustrated article describing the utilization of these tunnels for the handling of mail, express, and freight. 900 w. Eng News—March 17, 1904. No. 61450.

Compressed Air.

Compressed Air in Electric Railway Shop, Power House and Track Work. An illustrated article reviewing the uses to which air under compression can be applied, and the methods and devices used. 7000 w. St Ry Rev—March 20, 1904. Serial. 1st part. No. 61726 C.

Cranford.

The Cranford Plant of the Public Service Corporation of New Jersey. A building constructed of concrete blocks and a system of piping that includes a steam header 81 feet long without a single valve in it are conspicuous features of this electric railway plant. 3000 w. Eng Rec—March 19, 1904. No. 61469.

Electric Traction.

Electricity as a Substitute for Steam in Heavy Railroad Service. Arthur M. Waitt. Considers features relating to the practicability of the introduction of electricity on roads now using steam. 4800 w. Ry Age—March 4, 1904. No. 61267.

How Can We Haul by Electric Locomotives Freight Trains Weighing Twice as Much as Those Now Hauled by Steam Locomotives? H. Ward Leonard. Gives statistics showing the average train loads and cost of hauling, and predicts that economics will be effected by the use of electric locomotives. 600 w. Elec Wld & Engr—Feb. 27, 1904. No. 61110.

Past, Present and Future of Electric Traction. Frank J. Sprague. Reviews features in the development. 3000 w. Elec Wld & Engr—March 5, 1904. No. 61343.

The Electrification of the Liverpool and Southport Railway. An illustrated detailed description of this new departure. 7000 w. Engng—March 18, 1904. No. 61769 A.

The First Commercial Electric Street Railway in America. An illustrated account of the line in Baltimore, opened August 10, 1885, and interesting matters related. 2200 w. Elec Wld & Engr—March 5, 1904. No. 61340.

The First Electric Street Car in America—1884. E. M. Bentley. An account of the opening of a line a mile long in Cleveland, Ohio, the system installed, the difficulties, &c. Also notices of other early work in this field. 2500 w. Elec Wld & Engr—March 5, 1904. No. 61336.

English Tramways.

The Railways and the Tramways. Editorial discussion of the attitude of the great railways toward the tramways. 2000 w. Engng—Feb. 19, 1904. No. 61151 A.

Escalator.

The Escalator. Charles D. Seeberger. Illustrated description of a moving stairway. Cassier's Mag—March, 1904. No. 61585 B.

France.

The French Railways and Tramways in 1902. C. Colson. A review of the lines, their earnings, needed expenditure, and the general condition. 3000 w. Bul Int Ry Cong—Feb., 1904. No. 61130 E.

Isle of Man.

The Manx Electric Railway. Illustrated description of an interesting and picturesque road. 9500 w. St Ry Jour—March 5, 1904. No. 61260 C.

Jungfrau.

The Jungfrau Railway. Points of interest in regard to this unique railway of Europe, which is to be carried 4,093 meters above sea level. Ills. 1800 w. St Ry Rev—March 20, 1904. No. 61729 C.

Light-Railway.

The Barking-Becton Light Railway. Illustrates and describes the interlocking

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devices which control the opening of the bridge which crosses the river Roding, and gives information concerning the line. 1500 w. Elect'n, Lond—Feb. 26, 1904. No. 61302 A.

London.

London Traffic—An Unsolved Problem. J. Swinburne. Discusses the conditions in London, suggesting means of improving them. 4000 w. Cassier's Mag—March, 1904. No. 61582 B.

The Great Northern and City Railway. An illustrated description of London's latest "tube," with facts concerning it. 3500 w. St Ry Jour—March 5, 1904. No. 61259 C.

The London Traffic Problem. Brief review of changes in modes of conveyance, outlining an ideal system, and describing existing conditions and facilities, discussing possible solutions. Ills. 6200 w. Tram & Ry Wld—March 10, 1904. No. 61593 B.

Los Angeles.

Organization and Operating Features of the Pacific Electric Railway Company's System. Discusses in detail interesting operating features in Los Angeles and interurban systems. Ills. 4500 w. St Ry Jour—March 26, 1904. No. 61750 C.

The Pacific Electric Railway Company's System. Gives a map of the region around Los Angeles, Cal., showing the various lines, and an illustrated description of the distinctive points of the physical features and operation of this road. 4800 w. St Ry Jour—Feb. 27, 1904. Serial. 1s part. No. 61115 C.

Lubrication.

Street Car Lubrication. George L. Fowler. Considers the variation in practice and discusses the importance of the subject, and means of securing the best results. 2200 w. St Ry Jour—March 19, 1904. No. 61479 C.

Main Lines.

Electrification of the Liverpool-Southport Line—L. & Y. Railway. J. A. F. Aspinwall. A full illustrated account of the first main line steam railway in England to be partially equipped for handling passenger traffic by electric power. 8500 w. Mech Engr (Sup.)—March 19, 1904. No. 61762 A.

The Railway Electrification Problem. F. F. Bennett. Read before the Inst. of Elec. Engrs. Discusses the question as related to traffic in England and Wales. 2000 w. Mech Engr—March 12, 1904. Serial. 1st part. No. 61490 A.

Manchester, Eng.

The Tramway System of Manchester. An illustrated account of the tramway system as now completed. 10500 w. Tram & Ry Wld—March 10, 1904. No. 61592 B.

New York.

New York and Its Urban Traffic. From *Zeitung des Vereins*. An interesting review of the means of transport, with map and explanation of conditions. 5000 w. Bul Int Ry Cong—Feb., 1904. No. 61129 E.

New York Rapid Transit. F. O. Dufour. Reviews the attempts made to secure rapid transit for New York, describing the construction of the underground railway and giving its history. Ill. 4200 w. Wis Engr—Feb., 1904. No. 61180 D.

Ohio.

Electric Railways in Ohio. A statement of the present conditions in the State, showing great progress, and also stating the causes which have retarded the building of electric railways. 2800 w. St Ry Jour—March 12, 1904. No. 61378 C.

The Western Ohio Railway Co. Illustrates and describes the company's lines, power house, sub-stations, etc., with a revie wof some operating details. 5000 w. St Ry Rev—March 20, 1904. No. 61725 C.

Pacific.

Power Station, Rolling Stock and Dispatching System of the Pacific Electric Railway Company. Illustrated detailed description. 5500 w. St Ry Jour—March 12, 1904. No. 61377 C.

Power House.

Equipment of a Large French Railway Power House. C. Domar. Illustrated description of a generating station for the Paris, Metropolitan road. 3000 w. Am Elect'n—March, 1004. No. 61208.

Rail Joints.

Cast-Welded Joints. Albert B. Herrick. Reviews the history of these joints and the difficulties encountered, with some facts in regard to their value. 1200 w. St Ry Jour—March 5, 1904. No. 61262 C.

Rail Joints and Their Relation to Pavements. C. R. Van Buskirk. Read before the Brooklyn Engrs.' Club. Reviews the troubles that have been experienced and advocates the use either of the Weber joint, or welding. 3000 w. St Ry Jour—Feb. 27, 1904. No. 61117 C.

Railway Motors.

The Alternating Railway Motor Situation. Louis Bell. Briefly considers the various systems for operating electric roads, discussing the motors already brought into notice. 2000 w. St Ry Jour—Feb. 27, 1004. No. 61116 C.

Rapid Transit.

Section Five A, Second Division, New York Rapid Transit Railroad. Illustrated description of a section passing from 41st Street and Park Avenue to 47th Street and Broadway, and containing many diffi-

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cult problems. 2000 w. Eng Rec—March 5, 1904. No. 61236.

Repairs.

Repair Shop Practice of the Pacific Electric Railway Company. Illustrated description of the Los Angeles shops and their equipment. 6500 w. St Ry Jour—March 19, 1904. No. 61478 C.

Sanding.

Sand Braking for Tramways (Sandbremse für Elektrische und andere Bahnen). Describing an electrically-operated sand box and distributor for tramway use. 1000 w. Glasers Annalen—Feb. 15, 1904. No. 61633 D.

Single Phase.

Single-Phase Electric Railways (Ueber Einphasenbahnen). Dr. Friedrich Eichberg. An address before the Vienna Elektrotechnischen Verein, reviewing the recent successful applications of single-phase railway motors. Two articles. 5000 w. Zeitschr f Elektrotechnik—Feb. 28, March 6, 1904. No. 61663 each D.

Single-Phase Electric Traction. W. Perren Maycock. A comparison of the single-phase and direct-current methods, discussing the advantages of the former. 1800 w. Trac & Trans—March, 1904. No. 61320 E.

The Single-Phase Railway System of the Union Elektrizitäts-Gesellschaft (Das Einphasen-Bahnsystem der Union Elektrizitäts-Gesellschaft). Dr. Friedrich Eichberg. Describing especially the experimental work on the Nieder-Schöneweide-Spindlersfeld experimental line. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 27, 1904. No. 61609 D.

The Ward Leonard Single-Phase Locomotive. G. T. Hanchett. An illustrated description of this system, with a statement of the advantages and disadvantages over the ordinary heavy system of multiple unit direct-current traction. 2500 w. Elec Wld & Engr—March 5, 1904. No. 61344.

Sub-Stations.

Equipment of Sub-Stations — North-Eastern Railway. Illustrates and describes very interesting plants. 1500 w. Tram & Ry Wld—March 10, 1904. No. 61594 B.

Substructure.

Steel Railroad Substructure. A system of supporting railroad rails on a continuous line of inverted trough-shaped girders, invented by Samuel E. Duff, is illustrated and described. 1200 w. R R Gaz—March 11, 1904. No. 61365.

Subway.

Progress on the East Boston Subway. Describes interesting construction work on this tunnel, which passes under Boston Harbor and under the streets of the city. Ills. 4000 w. Ry & Engng Rev—March 12, 1904. No. 61395.

Switzerland.

Swiss Electric Railroading. Franz Koster. Illustrated description of the Lausanne-Moudon railway system. 1600 w. Elec Rev, N Y—March 5, 1904. No. 61270.

Through Booking.

Through Booking and Conveyance of Passengers, Parcels and Merchandise on Tramways and Light Railways. T. Upton. A discussion of the phases of the subject from an English point of view. 1500 w. Elec Rev, Lond—March 11, 1904. Serial. 1st part. No. 61497 A.

Trolley.

A New Form of Trolley for Electric Railways (Ueber eine Neue Stromzufuhrungsanlage für Elektrische Bahnen). E. Thomann. Illustrating and describing an improved form of sliding contact trolley, enabling current to be taken from overhead wires by the side of a main-line railway track. 2500 w. Schweiz Bauzeitung—Feb. 13, 1904. No. 61646 B.

Electric Locomotive with Overhead Trolley (Locomotive Electrique et Prise de Courant pour Ligne Aérienne). Illustrating a locomotive with improved sliding-contact trolley, built by the Oerlikon works. 1000 w. Génie Civil—March 12, 1904. No. 61630 D.

Urban Traffic.

The Encouragement of Urban Traffic. R. W. Western. Reaches the conclusion that it is wiser to study the passenger's time than his comfort, and considers the ways of securing rapid service. 2400 w. St Ry Jour—March 20, 1904. No. 61730 C.

Wheels.

Steel-Tired Wheels on the Boston Elevated Railway System. Illustrates and describes the methods adopted to keep the wheels absolutely round, and the repairs to the wheels. 1600 w. St Ry Jour—March 26, 1904. No. 61749 C.

The Fused Steel-Tired Wheel. Knox Taylor. Illustrates and describes a wheel of American production coming into service for high-speed electric railways. 1400 w. St Ry Jour—March 5, 1904. No. 61261 C.

Zanesville, O.

Zanesville Railway Light and Power Co. Illustrated description of this company's new plant, which comprises a steam turbine equipment and a water-power plant, combined with storage battery for reserve. 2500 w. St Ry Rev—March 20, 1904. No. 61727 C.

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EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Itál. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.

Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. c. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.